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Vulnerabilität älterer Menschen gegenüber Luftverunreinigungen, Klimawandel, Lärm und Chemikalien (Literaturstudie)

Abschlussbericht

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Vulnerabilität älterer Menschen gegenüber Luftverunreinigungen, Klimawandel, Lärm und Chemikalien (Literaturstudie)

Abschlussbericht

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Kurzbeschreibung: Vulnerabilität älterer Menschen gegenüber Luftverunreinigungen, Klimawandel, Lärm und Chemikalien (Literaturstudie)

Ziel des Vorhabens war es, die aktuelle Studienlage hinsichtlich der Vulnerabilität älterer Menschen gegenüber gesundheitsrelevanten Umwelteinflüssen zu erfassen. In einer systematischen Übersichtsarbeit wurden insgesamt 466 Studien zur Exposition mit ***Luftbelastungen*** (Feinstaub, Stickstoffdioxid, Ozon, Schwermetalle, flüchtige organische Verbindungen, Benzol, Bioaerosole), 95 Studien zur Exposition durch den ***Klimawandel*** (Hitze, Sturm/Starkregen, Hochwasser/Überflutung), 53 Studien zur Exposition mit ***Lärm*** (Industrie-, Freizeit-, Verkehrslärm) und 101 Studien zur Exposition mit ***Chemikalien*** (Arsen, Bisphenol A, per- und polyfluorierte Chemikalien, polychlorierte Biphenyle, Schwermetalle, Phthalate, persistente organische Schadstoffe) aus dem Zeitraum 2003 bis 2019 identifiziert.

Die identifizierten Studien weisen eine starke Heterogenität im Hinblick auf die untersuchten Expositionen und Outcomes auf. Diese Heterogenität zeigt sich in der Vielfalt der beschriebenen Morbidität. Auch wenn über alle Umwelteinflüsse hinweg ein deutlicher Schwerpunkt in den Auswirkungen auf Erkrankungen des Herz-Kreislauf- und des Atemsystems liegt, so sind die konkret spezifizierten Krankheiten sehr vielfältig. Auch die analysierten Expositionen weisen eine hohe Bandbreite auf. Weiterhin spiegeln die Studienmerkmale und die einbezogenen Kofaktoren unterschiedlichste Bedingungen, unter denen die Studien durchgeführt wurden, wider. Folglich zeigen die Ergebnisse der Studien häufig inkonsistente oder widersprüchliche Effekte.

Abstract: Vulnerability of older people to air pollution, climate change, noise and chemicals (literature search)

The aim of this project was to provide a comprehensive overview of the current state of science and latest research on the vulnerability of the elderly to health-related environmental factors. Therefore, a systematic review was conducted, resulting in the identification of 466 publications on the exposition to **air pollution** (particulate matters, nitrogen dioxide, ozone, heavy metals, volatile organic compounds, benzene, bioaerosols), 95 publications on the exposition to **climate change** (heat, storm/heavy rain, flood), 53 publications on the exposition to **noise** (industry, traffic, leisure activities) and 101 publications on the exposition to **chemicals** (arsenic, bisphenol A, perfluorinated alkylated substances, polychlorinated biphenyl, heavy metals, phthalates, persistent organic pollutants) all of which were published between 2003 and 2018.

It should be noted that the identified studies display vast heterogeneities regarding their investigated exposition and outcome, respectively. This can e.g. be seen in the large variety of morbidity descriptions. While a focus on the impacts on cardiovascular and respiratory diseases could be identified across all environmental influences, a closer look reveals that the specific diseases are notably diverse. The same is true for the different expositions. Moreover, a broad range of study characters and incorporated cofactors was found, further pointing towards the amount of discrepancies between the different study implementations. Consequently, it comes naturally that studies often draw inconsistent or contradictory conclusions on the effects of interest.

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Abkürzungsverzeichnis

BfR	Bundesinstitut für Risikobewertung
EFSA	European Food Safety Authority
MeSH	Medical Subject Headings (Thesaurus der Datenbank MEDLINE)
PCBs	polychlorierte Biphenyle
PECO	Population Exposition Comparator Outcome
PFAS	per- und polyfluorierte Alkylverbindungen
PFCs	per- und polyfluorierte Chemikalien
PFOA	Perfluoroctansäure
PM2.5	Feinstaubfraktion, Teilchen mit einem Durchmesser von 2,5 µm
PM10	Feinstaubfraktion, Teilchen mit einem Durchmesser von 10 µm
POPs	persistente organische Schadstoffe
SVOC	schwerflüchtige organische Verbindungen
VOC	flüchtige organische Verbindungen
VVOC	leicht flüchtige organische Verbindungen
WoS	Web of Science

Zusammenfassung

Hintergrund und Problemstellung

Vor dem Hintergrund des demografischen Wandels ist eine stärkere Berücksichtigung höherer Altersgruppen in der umweltbezogenen Gesundheitsforschung erforderlich, da angenommen wird, dass ältere Menschen aufgrund von altersphysiologischen Veränderungen und Schadstoffakkumulationen über die Lebensjahre hinweg eine besonders vulnerable Gruppe mit Blick auf spezifische Umwelteinflüsse darstellen.

Ziel und Gegenstand des Forschungsprojektes

Ziel des Vorhabens war es, die aktuelle Studienlage hinsichtlich der Vulnerabilität älterer Menschen gegenüber gesundheitsrelevanten Umwelteinflüssen zu erfassen. In einer systematischen Übersichtsarbeit wurden Publikationen zu gesundheitlichen Auswirkungen und Auswirkungen auf die Gesundheitsinfrastruktur (d.h. die Belastung der Rettungsdienste, Krankenhäuser und Ärzte) infolge von

- ***Luftbelastungen*** (Benzol (C_6H_6), Bioaerosolen, Feinstaub (PM10, PM2.5, ultrafeine Partikel), flüchtigen organischen Verbindungen (SVOC, VOC, VVOC), Ozon (O_3), Stickstoffdioxid (NO_2), Schwermetallen),
- ***Klimawandel*** (Hitzebelastungen, Hochwasser, Starkregen, Stürme, Überflutung),
- ***Lärm*** (Freizeit- und Nachbarschaftslärm, Industrielärm, Verkehrslärm) und
- ***Chemikalien*** (Arsen (As), Bisphenol A (BPA), per- und polyfluorierte Chemikalien (PFCs/PFAS), persistente organische Schadstoffe (POP), polychlorierte Biphenyle (PCBs), Schwermetalle, Weichmacher/Phthalate)

identifiziert und im Hinblick auf drei Fragestellungen bewertet:

- Inwiefern weisen ältere Menschen eine besondere Vulnerabilität gegenüber Umwelteinflüssen durch ***Luftbelastungen***, ***Lärm***, ***Chemikalien*** und dem ***Klimawandel*** im Vergleich zu jüngeren Altersgruppen auf?
- Welchen Umwelteinflüssen kommt dabei die größte Relevanz zu?
- Welche Unterschiede lassen sich innerhalb der Gruppe der älteren Menschen erkennen (z. B. in Bezug auf Geschlecht, Altersgruppe, soziodemografische Merkmale)?

Methode

Die Recherche zur Identifizierung von Studien bzw. Publikationen zur Vulnerabilität älterer Menschen gegenüber Umweltbelastungen wurde nach den Prinzipien einer systematischen Übersichtsarbeit (Systematic Review) durchgeführt. Nach der Definition der Suchbegriffe und der Formulierung der Suchgleichungen erfolgte die Suche in den multidisziplinären Datenbanken (i) Scopus, (ii) Web of Science und über die Plattform (iii) LIVIVO in den fachspezifischen Datenbanken BASE, Bibliothek des Bundesinstituts für Risikobewertung, Bibliothek des Bundesamts für Verbraucherschutz und Lebensmittelsicherheit, Katalog der US National Library of Medicine, Katalog der Technischen Informationsbibliothek Hannover, ZB MED Katalog Medizin, Gesundheit, Ernährung, Umwelt & Agrar, MEDLINE, PSYNDEX, SOMED und UFORDAT. Außerdem wurde systematisch im Internet über (iv) Google und (v) Google

Scholar gesucht. Gesucht wurden wissenschaftliche Publikationen oder Berichte, die sich mit der Vulnerabilität (Morbidität, Mortalität sowie Notfalleinsätzen der Rettungsdienste, Krankenhausaufnahmen) exponierter älterer Menschen im Vergleich zu exponierten jüngeren Menschen und/oder im Vergleich zu nichtexponierten älteren Menschen beschäftigen. Einschlusskriterien waren das Datum (nicht älter als 15 Jahre), die Sprache (Englisch, Deutsch), das Format (wissenschaftlicher Artikel, Forschungsbericht) und die Verfügbarkeit (Volltext) der Publikation. Die Suche fand im November 2018 (Literaturdatenbanken) bzw. Anfang 2019 (Internet) statt.

Alle Suchergebnisse wurden in einem Referenzmanagementsystem zusammengeführt. Nach Entfernung der Duplikate wurden die Publikationen auf die Einhaltung der Einschlusskriterien geprüft. Dazu erfolgte in einem ersten Schritt die Extraktion der in den Titeln und Abstracts verfügbaren Informationen zur Studienpopulation, zu untersuchten Umwelteinflüssen und ihren Auswirkungen, zu Studientyp und zur Sprache der Publikation. Über diese Informationen wurden nicht relevante Studien ausgeschlossen. In einem zweiten Schritt wurden die Volltexte gesichtet, weitere Informationen extrahiert und ergänzt und auf dieser Basis weitere Studien ausgeschlossen. Für die letztendlich selektierten Studien erfolgten die Extraktion der Ergebnisse und die Bewertung der Qualität. Die Ergebnisse bezogen auf die Vulnerabilität der Gruppe der älteren Menschen wurden in drei Kategorien eingeteilt (+ erhöhte Vulnerabilität, 0 gleiche Vulnerabilität, - verringerte Vulnerabilität). Eine einfache Qualitätsbenotung erfolgte auf einer Skala (+ sehr niedrig, ++ niedrig, +++ moderat, ++++ hoch) als Summenscore aus vier Studiendesign-Kriterien (Studientyp, kontrollierte Exposition, Einzeldaten, Vergleichsgruppe).

Alle identifizierten (ein- und ausgeschlossenen) Publikationen sowie die extrahierten Informationen zu Einschlusskriterien, Ergebnissen und Qualität wurden in Tabellenform abgelegt, so dass eine Sortierung/Selektion erfolgen kann.

Ergebnisse

In den fünf verschiedenen Suchbereichen (Scopus, Web of Science, LIVIVO, Google und Google Scholar) wurden zur Exposition ***Chemikalien*** 857 Publikationen, zur Exposition ***Klimawandel*** 629 Publikationen, zur Exposition ***Lärm*** 749 Publikationen und zur Exposition ***Luftbelastungen*** 3.734 Publikationen, insgesamt also 5.969 Publikationen identifiziert.

Nach Ausschluss der Duplikate und Prüfung der Studien auf Einhaltung der Einschlusskriterien konnten zur Exposition ***Chemikalien*** 101 Publikationen, zur Exposition ***Klimawandel*** 95 Publikationen, zur Exposition ***Lärm*** 53 Publikationen und zur Exposition ***Luftbelastung***en 466 Publikationen, insgesamt also 715 Publikationen in die Synthese der Ergebnisse einbezogen werden.

Die Studien zur Vulnerabilität älterer Menschen gegenüber Umwelteinflüssen durch ***Chemikalien*** kamen zu 42 % aus Amerika, zu 29 % aus Asien und zu 23 % aus Europa. In den 101 Studien wurden die Auswirkungen von Arsen (37 Studien), Bisphenol A (7 Studien), per- und polyfluorierten Chemikalien (9 Studien), polychlorierten Biphenylen (8 Studien), Schwermetallen (8 Studien), Weichmachern/Phthalaten (7 Studien) und persistenten organischen Schadstoffen (25 Studien) auf Morbidität (83 Studien) und Mortalität (19 Studien) betrachtet. Die Studien zu ***Chemikalien*** berücksichtigen auch die Schadstoffakkumulationen über die Lebensjahre, die diese Altersgruppe besonders vulnerabel machen.

Die Studien zur Vulnerabilität älterer Menschen gegenüber Umwelteinflüssen durch den ***Klimawandel*** kamen zu 21 % aus Amerika, zu 39 % aus Asien und zu 30 % aus Europa. In den 95 Studien wurden die Auswirkungen von Hitzebelastungen (88 Studien), Hochwasser/Überflutung (2 Studien) und Sturm/Starkregen (5 Studien) auf

Gesundheitsinfrastruktur (23 Studien), Morbidität (17 Studien) und Mortalität (55 Studien) betrachtet. Die Studien zeigen eine erhöhte Vulnerabilität der über 60-Jährigen und insbesondere der über 75-Jährigen. Mortalität bzw. medizinische Notfälle steigen in dieser Altersgruppe hitzebedingt und bei hohen Tagestemperaturschwankungen deutlich an.

Die Studien zur Vulnerabilität älterer Menschen gegenüber Umwelteinflüssen durch ***Lärm*** kamen zu 17 % aus Amerika, zu 11 % aus Asien und zu 68 % aus Europa. In den 53 Studien wurden die Auswirkungen von Alltagslärm (4 Studien), Industrielärm (9 Studien) und Verkehrslärm (40 Studien) auf Morbidität (47 Studien) und Mortalität (6 Studien) betrachtet. Gegenüber Lärmbelästigungen sind Ältere ähnlich vulnerabel wie alle anderen Altersgruppen.

Die Studien zur Vulnerabilität älterer Menschen gegenüber Umwelteinflüssen durch ***Luftbelastungen*** kamen zu 40 % aus Amerika, zu 30 % aus Asien und zu 28 % aus Europa. In den 466 Studien wurden die Auswirkungen von Benzol (2 Studien), Bioaerosolen (7 Studien), Feinstaub (384 Studien), Ozon (16 Studien), Schwermetallen (22 Studien), Stickstoffdioxid (34 Studien) und VOC (1 Studie) auf die Gesundheitsinfrastruktur (83 Studien), die Morbidität (218 Studien) und Mortalität (166 Studien) betrachtet. Die sehr hohe Anzahl der Studien zu Feinstaub belegt, dass insbesondere dieses Thema im hier untersuchten Zeitraum enorme Beachtung gefunden hat.

Die identifizierten Studien weisen eine starke Heterogenität im Hinblick auf die untersuchten Expositionen und Outcomes auf. Diese Heterogenität zeigt sich in der Vielfalt der beschriebenen Morbidität. Auch wenn über alle Umwelteinflüsse hinweg ein deutlicher Schwerpunkt in den Auswirkungen auf das Kreislaufsystem und die Atemwege liegt, sind die konkret spezifizierten Erkrankungen sehr vielfältig. Auch die analysierten Expositionen weisen eine hohe Bandbreite auf. Weiterhin spiegeln die Studienmerkmale und die einbezogenen Kofaktoren unterschiedlichste Bedingungen, unter denen die Studien durchgeführt wurden, wider. Diese Heterogenität liegt in der Natur der epidemiologischen (nicht-interventionellen, Beobachtungs-) Studien. Die Exposition durch Umwelteinflüsse ist kaum kontrollierbar und der Zusammenhang zwischen Kofaktoren und Exposition teilweise schwer zu erfassen. Folglich zeigen die Ergebnisse der Studien oftmals inkonsistente oder widersprüchliche Effekte.

Eine Einschätzung der Relevanz der Umwelteinflüsse anhand der Anzahl identifizierter Studien stellt Luftbelastungen durch Feinstaub (allein oder in Kombination mit Ozon, Stickstoffoxiden, Kohlenstoffoxiden, Hitzebelastungen o.a.) deutlich an oberste Stelle. Im Hinblick auf den Einfluss auf die Gesundheitsinfrastruktur wurden die meisten Studien zu Hitzebelastungen identifiziert.

Die betrachteten Studien untersuchen auch den Einfluss von Kofaktoren auf die Vulnerabilität. Dabei zeigen sich je nach Art der Umweltbelastung unterschiedliche Schwerpunkte. In nahezu allen Studien erfolgt eine Differenzierung nach Geschlecht. Alle anderen Kofaktoren unterscheiden sich von Studie zu Studie, auch in Abhängigkeit von konkret untersuchter Exposition und Erkrankung.

Zur Qualitätsbewertung der Studien wurde eine einfache Skala angewandt. Ein Großteil der Studien zeigt insbesondere die für epidemiologische Studien typische qualitative Schwäche der nicht kontrollierten Exposition.

Insgesamt konnte eine große Anzahl von Studien zur Vulnerabilität älterer Menschen identifiziert werden. Das belegt die weltweit hohe Relevanz des Themas und die aktive Forschung daran.

Summary

Setting and motivation

Today's demographic change demands that research on environmental influences on health-related issues should put a greater focus on older age groups, since the elderly are expected to be particularly vulnerable to certain influences due to the physiological changes and long-term accumulation of pollutants that come with old age.

Aim of this research project

The aim of this project was to provide a comprehensive overview over the current state of science and latest research on the vulnerability of the elderly to health-related environmental factors. A systematic review was conducted, identifying relevant studies on the effects on health and healthcare infrastructure (i.e. the burden on emergency services, hospitals and doctors) due to the exposure to

- ***Air pollution*** (benzene (B_6H_6), bioaerosols, nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM10, PM2.5, ultrafine particles), heavy metals, volatile organic compounds (SVOC, VOC, VVOC)),
- ***Climate change*** (flood, heat stress, heavy rain, storm),
- ***Noise pollution*** (recreational and neighborhood noise, industry noise, traffic noise),
- ***Chemical pollution*** (arsenic (As), bisphenol A (BPA), heavy metals, perfluorinated alkylated substances (PFCs/PFAS), persistent organic pollutants (POP), plasticizers/phthalates, polychlorinated biphenyls (PCBs))

and evaluated them regarding three questions:

- In what sense do the elderly show a particular vulnerability to environmental influences such as ***air pollution, climate change, noise pollution*** and ***chemical pollution*** in contrast to younger age groups?
- Which environmental influences are considered the most relevant?
- Which differences can be identified within the group of the elderly (*i.e.* with respect to sex, more specific age group, socio-demographic characteristics)?

Method

In order to identify studies on the vulnerability of the elderly to environmental influences, the investigation was conducted as a systematic review. First, search terms and search strings were defined and implemented in the search query in the multidisciplinary databases (i) Scopus and (ii) Web of Science and (iii) subject-specific LIVIVO databases BASE, *Bibliothek des Bundesinstituts für Risikobewertung*, *Bibliothek des Bundesamts für Verbraucherschutz und Lebensmittelsicherheit*, MEDLINE, PSYNDEX, SOMED, UFORDAT and catalogs of the US National Library of Medicine Catalog, of the Leibniz Information Centre for Science and Technology University Library (TIB) and of the ZB MED (medicine, health, nutrition, environment and agriculture). In addition, a systematic internet search was done via (iv) Google and (v) Google Scholar. The goal was to find scientific publications or reports on the vulnerability (*i.e.* morbidity, mortality, emergency responses, hospitalization) of exposed elderly people in

comparison to exposed younger people and/or in comparison to non-exposed elderly people. The inclusion criteria were the date of publication (not older than 15 years), language (English, German), format (scientific publication or report) und availability (full text). The search was conducted in November 2018 (databases) and in the beginning of 2019 (internet).

All search results were compiled in a reference management software. After removing duplicates, all publications were inspected regarding the inclusion criteria. Moreover, information on each study's title, abstract, language, study population, investigated environmental influence(s) and their effect(s) as well as their study type were extracted in first extraction step and subsequently used to eliminate irrelevant studies. In a second step, full texts of the remaining studies were screened in order to extract more detailed information and further eliminate irrelevant studies. At this point, all remaining studies were selected which led to the extraction of their results and evaluation of their quality. Results on the vulnerability of the elderly were rated according to a scheme with three groups (+ higher vulnerability, 0 similar vulnerability, - lower vulnerability). Quality was rated according to a scheme with four groups (+ very low, ++ low, +++ moderate, ++++high) which in turn results from a sum score on study design criteria (study type, controlled exposure, availability of individual data, comparator group).

All identified (*i.e.* both included and excluded) studies as well as the extracted information on inclusion criteria, results and quality were stored in spreadsheets, allowing for easy sorting and/or selecting.

Results

Searching the five sources (Scopus, Web of Science, LIVIVO, Google and Google Scholar) resulted in the identification of a total of 857 publications on the exposure to ***chemical pollutants***, 628 publications on the exposure to ***climate change***, 749 publications on the exposure to ***noise pollution*** and 5,969 publications on the exposure to ***air pollution***.

After removing duplicates and applying the inclusion criteria, the number of remaining publications was 101 for ***chemical pollutants***, 95 for ***climate change***, 53 for ***noise pollution*** and 466 for ***air pollution***, leading to a total of 715 selected publications.

Out of the 101 selected studies on the vulnerability of the elderly to environmental influences related to ***chemical pollutants***, 42 % were published in America, 29 % in Asia, and 23 % in Europe. Furthermore, in terms of the exposure, their focus lay on the effects of arsenic (37 studies), bisphenol A (7 studies), perfluorinated alkylated substances (9 studies), polychlorinated biphenyls (8 studies), heavy metals (8 studies), phthalates/plasticizers (7 studies), persistent organic pollutants (25 studies) on morbidity (83 studies) or mortality (19 studies), respectively. Studies on ***chemicals*** also considered lifetime accumulation making this age group especially vulnerable.

Out of the 95 selected studies on the vulnerability of the elderly to environmental influences related to ***climate change***, 21 % were published in America, 39 % in Asia, and 30 % in Europe. Furthermore, in terms of the exposure, their focus lay on the effects of heat stress (88 studies), floods (2 studies) or storm (5 studies) on infrastructure (23 studies), morbidity (17 studies) or mortality (55 studies), respectively. Studies found particularly people over 60 years, and especially over 75 years old to be affected. Mortality and/or medical emergency rates increased considerably when exposed to heat and/or large temperature fluctuations.

Out of the 53 selected studies on the vulnerability of the elderly to environmental influences related to ***noise pollution***, 17 % were published in America, 11 % in Asia, and 68 % in Europe. Furthermore, in terms of the exposure, their focus lay on the effects of noise in day-to-day life (4 studies), occupational/industrial noise (9 studies) or traffic noise (40 studies) on morbidity (47 studies) or mortality (6 studies), respectively. In terms of exposure to noise, the vulnerability of the elderly was comparable to that of other people in other age groups.

Out of the 466 selected studies on the vulnerability of the elderly to environmental influences related to ***air pollution*** 40 % were published in America, 30 % in Asia, and 28 % in Europe. Furthermore, in terms of the exposure, their focus lay on the effects of benzene (2 studies) bioaerosols (8 studies), particulate matter (384 studies), ozone (16 studies), heavy metals (22 studies), nitrogen dioxide (34 studies) or volatile organic compounds (1 study) on infrastructure (83 studies), morbidity (218 studies) or mortality (166 studies), respectively. The large number of studies on particulate matter shows that this topic in particular has received enormous attention in the period under review.

It should be noted that the identified studies display vast heterogeneities regarding their investigated exposure and outcome, respectively. This can e.g. be seen in the large variety of morbidity descriptions. While a focus on the impacts on cardiovascular and respiratory diseases could be identified across all environmental influences, a closer look reveals that the specific diseases are notably diverse. The same is true for the different exposures. Moreover, a broad range of study characters and incorporated cofactors was found, reflecting the different conditions under which the studies were conducted. This heterogeneity is in the nature of epidemiological (non-interventional, observational) studies. Exposure to environmental factors is difficult to control and the interactions between cofactors and exposure are sometimes difficult to grasp. Consequently, it comes naturally that studies often draw inconsistent or contradictory conclusions on the effects of interest.

When assessing the relevance of the different environmental influences based on the number of identified studies, **air pollution** due to particulate matter (by itself or in combination with ozone, nitrogen dioxide, carbon dioxide, heat stress *etc.*) is undoubtedly the most important. In terms of the impact on healthcare infrastructure, heat stress displays the largest number of identified studies.

Studies also investigated the effects of cofactors on vulnerability, while depending on the environmental influence there are different emphases. Only considering men and women separately was a constant in nearly all studies. All other cofactors differed between studies, mostly dependent on the specific exposure and the investigated disease.

A simple rating system was applied for quality assessment. Most of the studies exhibited the typical shortcoming of epidemiological studies, *i.e.* an uncontrolled exposure.

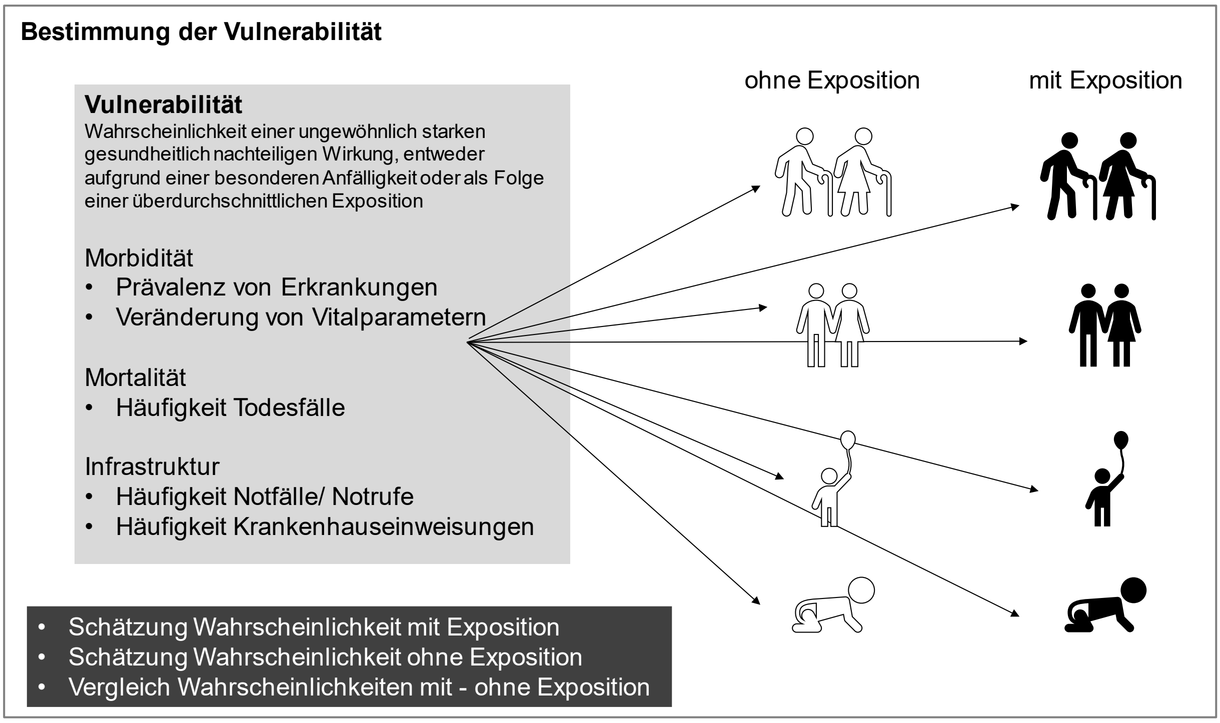
Overall, a large number of studies on the vulnerability of older people have been identified. This proves the high relevance of the topic worldwide and the active research on it.

1 Hintergrund und Problemstellung

Der Begriff der Vulnerabilität bezieht sich auf breites Spektrum sozialer, wirtschaftlicher, institutioneller und ökologischer Gefährdungen (Christmann et al., 2011). Allgemein wird darunter das Zusammenwirken der Anfälligkeit (Sensitivität) und der Anpassungskapazität eines Objekts oder Systems in Bezug auf den Umgang mit Gefahren gefasst (adelphi et al., 2015). Mit Blick auf die menschliche Gesundheit bedeutet Vulnerabilität, dass eine Person oder Bevölkerungsgruppe eine erhöhte Erkrankungs-, Behinderungs- und Sterbewahrscheinlichkeit aufweist, hilflos oder schutzbedürftig ist, besondere Unterstützung benötigt oder nicht in ausreichendem Maße für sich selbst sorgen kann (Larkin, 2009; Steinkühler et al., 2017).

In diesem Vorhaben ist Vulnerabilität konkret definiert als eine erhöhte Erkrankungs-, Behinderungs- und/oder Sterbewahrscheinlichkeit, also als die Wahrscheinlichkeit einer ungewöhnlich starken gesundheitlich nachteiligen Wirkung, entweder aufgrund einer besonderen Anfälligkeit oder als Folge einer überdurchschnittlichen Exposition. Sie wird gemessen an der Mortalität, Morbidität oder Inanspruchnahme der Gesundheitsdienste im Zusammenhang mit der untersuchten Exposition. Statistisch festgestellt wird die Vulnerabilität über Wahrscheinlichkeiten (Prävalenz von Erkrankungen, Häufigkeit von Todesfällen oder Häufigkeit von Arztbesuchen, Abbildung 1)

Abbildung 1: Bestimmung der Vulnerabilität



Quelle: eigene Darstellung BioMath GmbH

Das Ausmaß der gesundheitlichen Vulnerabilität wird bestimmt durch das Zusammenwirken von biologischen, psychosozialen und umweltbedingten Faktoren. Beispielsweise können bestehende Vorerkrankungen oder soziale Benachteiligung die Vulnerabilität gegenüber umweltbedingten Gesundheitsbelastungen erhöhen.

Im Kontext von Umwelt und Gesundheit kommt der Vulnerabilität bestimmter Bevölkerungsgruppen, insbesondere der Gruppe älterer Menschen eine besondere Bedeutung zu. Zwar ist ein fortgeschrittenes Alter nicht pauschal mit Krankheit gleichzusetzen, jedoch geht man bei älteren Menschen im Vergleich zu Jüngeren beispielsweise von einer höheren Empfindlichkeit gegenüber Feinstaub sowie von höheren Konzentrationen von Schwermetallen im Blut durch lebenslange Schadstoffakkumulationen (u. a. Cadmium, Blei und Quecksilber) aus (Choi et al., 2017). Zudem sind alte und hochaltrige Personen physiologisch bedingt besonders vulnerabel gegenüber Hitzebelastungen (Eis et al., 2010).

Vor dem Hintergrund des demografischen Wandels, der in Deutschland durch den zunehmenden Anteil älterer Menschen insgesamt zu einer Alterung der Bevölkerung führt, ist eine stärkere Berücksichtigung höherer Altersgruppen in der umweltbezogenen Gesundheitsforschung erforderlich. Die demografische Alterung fördert z. B. den Anstieg der Fallzahlen altersbedingter chronischer Erkrankungen. Das Vorhaben sollte daher den aktuellen Stand der Forschung zur Vulnerabilität älterer Menschen als Basis für Untersuchungen zum Zusammenhang zwischen dem demografischen Wandel und umweltbedingten Gesundheitsrisiken ermitteln.

2 Ziel und Gegenstand des Forschungsprojekts

Im Rahmen dieses Vorhabens wurde anhand einer systematischen Übersichtsarbeit untersucht, inwiefern ältere Menschen eine vulnerable Bevölkerungsgruppe in Bezug auf Belastungen durch ***Luftverschmutzung***, ***Klimawandel***, ***Lärm*** und ***Chemikalien*** darstellen. Unter älteren Menschen werden üblicherweise Menschen im dritten (65 bis 84 Jahre) und vierten (85 Jahre und älter; hochaltrig) Lebensabschnitt bezeichnet. Ergänzend wurden auch Personen ab 60 Jahren berücksichtigt. Herauszuarbeiten waren dabei auch etwaige Geschlechterunterschiede, sowie der Einfluss der sozialen Lage auf die Vulnerabilität dieser Bevölkerungsgruppe.

Das Vorhaben dient der Schaffung einer Grundlage für den adäquaten Schutz älterer Menschen vor umweltbezogenen Gesundheitsrisiken. Die Aufbereitung des aktuellen Forschungsstands zu dem angeführten Thema kann dementsprechend den Ausgangspunkt für spezifische Maßnahmen und weitere Forschung je nach Relevanz der betrachteten Stressoren bilden, um der besonderen Empfindlichkeit älterer Menschen bei der Bewertung von Umwelteinflüssen Rechnung zu tragen. Aufbauend auf den Ergebnissen dieses Vorhabens sollen ältere Menschen gezielter vor umweltbedingten Gesundheitsbelastungen geschützt und Empfehlungen für zielgruppenadäquate Maßnahmen abgeleitet werden.

Um das Ziel des Vorhabens umzusetzen, wurde die aktuelle Studienlage hinsichtlich der Vulnerabilität älterer Menschen gegenüber gesundheitsrelevanten Umwelteinflüssen mittels einer systematischen Literaturübersicht erfasst, dargestellt und kritisch bewertet.

Die zentral übergeordneten Forschungsfragen des Vorhabens waren:

- Inwiefern weisen ältere Menschen eine besondere Vulnerabilität gegenüber Umwelteinflüssen durch ***Luftbelastungen***, ***Lärm***, ***Chemikalien*** und dem ***Klimawandel*** im Vergleich zu jüngeren Altersgruppen auf?
- Welchen Umwelteinflüssen kommt dabei die größte Relevanz zu?
- Welche Unterschiede lassen sich innerhalb der Gruppe der älteren Menschen erkennen (z. B. in Bezug auf Geschlecht, Altersgruppe, soziodemografische Merkmale)?

3 Methode: Systematische Übersichtsarbeit in Form eines Scoping Reviews

Die Literaturrecherche zur Identifizierung von Studien zur Vulnerabilität älterer Menschen gegenüber Umweltbelastungen wurde nach den Prinzipien einer systematischen Übersichtsarbeit als Scoping Review durchgeführt. Seit den 1990er Jahren hat die Forderung nach evidenzbasierter Praxis stark zugenommen, was sich in einer steigenden Anzahl von publizierten Übersichtarbeiten widerspiegelt. Der methodische Ansatz und entsprechende Richtlinien wurden vor allem im Bereich der Medizin entwickelt und für zahlreiche andere Bereiche adaptiert (Centre for Evidence-based Conservation, 2010; Centre for Reviews and Dissemination, 2009; European Food Safety Authority, 2010; Arksey und O'Malley, 2005; Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, 2014; Bragge et al., 2011; Daudt et al., 2013; Hidalgo Landa et al., 2011; Higgins und Green, 2011; Hoffmann et al., 2017; Kohl et al., 2013; Levac et al., 2010; Miake-Lye et al., 2016; Sargeant et al., 2005; U.S. Food and Drug Administration, 2009). Der systematische Ansatz ist nicht nur in der Recherche nach wissenschaftlichen Publikationen, sondern auch in der Suche nach grauer Literatur anwendbar (Godin et al., 2015).

Die Prinzipien verschiedener Formen von systematischen Übersichtsarbeiten sind in Tabelle 1 dargestellt.

Tabelle 1: Prinzipien von Narrative, Scoping und Systematic Reviews (nach Kohl et al., 2013)

	Narrative Review	Scoping Review		Systematic Review
Studienfrage	Oft breit gefasst	Breit und explizit	Fokussiert und explizit	Fokussiert und explizit
Datenquellen	keine Spezifizierung durchsuchter Datenquellen	Umfassende Suche in elektronischen Datenbanken und nicht publizierten Daten		Umfassende Suche in elektronischen Datenbanken und nicht publizierten Daten
Suchstrategie	Keine explizite Suchstrategie	Explizite Suchstrategie im Vorfeld definiert		Explizite Suchstrategie im Vorfeld definiert
Eignungskriterien für Ein- und Ausschluss von Studien	Nicht explizit gefordert, potentiell verzerrt/einseitig	Vordefiniert und dokumentiert, objektiv angewandt (einheitliche Kriterien-basierte Selektion)		Vordefiniert und dokumentiert, objektiv angewandt (einheitliche Kriterien-basierte Selektion)
Beschreibung der Review-Methodik	Selten berichtet	Berichtet und in einem Protokoll vordefiniert		Berichtet und in einem Protokoll vordefiniert
Artikel-Durchsicht und Bewertung	Unterschiedlich, individuell, abhängig vom Durchführenden	Rigorose kritische Bewertung nach einem vorgegebenen Beurteilungsschema		Rigorose kritische Bewertung nach einem vorgegebenen Beurteilungsschema
Literatursuche	Nicht immer umfassend	Strukturiert, um so viele relevante Studien wie möglich zu identifizieren		Strukturiert, um so viele relevante Studien wie möglich zu identifizieren

	Narrative Review	Scoping Review	Systematic Review
Bewertung der methodischen Qualität eingeschlossener Studien	Unterschiedlich	Unterschiedlich	Immer, typischerweise anhand eines Qualitätsbewertungsschemas
Bericht der Studienergebnisse	Selektiv, oft abhängig vom Durchführenden	Vollständiger Bericht relevanter Ergebnisse	Vollständiger Bericht relevanter Ergebnisse (numerische Ergebnisse)
Synthese	Normalerweise qualitativ, manchmal selektiv	Normalerweise qualitativ	Quantitative Synthese (Meta-Analyse) wenn möglich

In einem Systematic Review werden alle zu einer konkreten Fragestellung vorhandenen Studien nach vorher genau festgelegten Kriterien gesucht, ausgewählt und bewertet. Systematic Reviews folgen strikten Standards und einer rigorosen Methodik: Mithilfe einer Suchstrategie mit vorab genau definierten Suchbegriffen wird nach allen Publikationen, die sich mit einer spezifizierten Fragestellung befassen, gesucht. Die Auswahl relevanter Studien erfolgt anhand von vorab definierten Ein- und Ausschlusskriterien. Zusätzlich wird die methodische Qualität der Studien bewertet. Wenn möglich, werden die Ergebnisse quantitativ synthetisiert (statistische Meta-Analyse).

Narrative Übersichtsarbeiten bieten im Gegensatz dazu meist nur einen breiten Überblick zu einem bestimmten Thema und haben häufig einen edukativen Charakter. Die Auswahl der berücksichtigten Literatur erfolgt subjektiv und unsystematisch, was die Gefahr einer erheblichen Verzerrung bei den Schlussfolgerungen birgt (Cochrane Deutschland, Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften - Institut für Medizinisches Wissensmanagement, 2017).

Ein Scoping Review umfasst eine weitere Art der Literaturrecherche, um relevante Literatur auf dem Gebiet von Interesse zu "kartieren". Ein Scoping Review behandelt tendenziell umfassendere Themen als eine systematische Übersichtsarbeit. Die systematische Überprüfung der Literatur zielt darauf ab, Antworten auf Fragen aus einem relativ breiten Spektrum von Studien zu eher nicht spezifischen Forschungsfragen zu liefern. Scoping Reviews liefern zudem eine deskriptive Zusammenfassung der Literatur. Eine kritische Bewertung der eingeschlossenen Studien erfolgt dabei in der Regel nicht. Durch die quantitative Darstellung der vorhandenen Forschung erlauben diese Formen der aggregierten Evidenz vor allem eine Darstellung der Forschungslandschaft und das Erkennen von Forschungsbedarf (Arksey und O'Malley, 2005; Miake-Lye et al., 2016; Levac et al., 2010).

Ein Scoping Review läuft prinzipiell in sechs Schritten ab:

1. Vorbereitung
2. Literatursuche
3. Studienauswahl nach Ein- und Ausschlusskriterien
4. Datenextraktion aus eingeschlossenen Studien
5. Synthese und Analyse der Daten
6. Präsentation/Publikation der Daten und Ergebnisse

Die Vorbereitung (Schritt 1) umfasst die Entwicklung der Suchstrategie (s. 3.1), die die wesentlichen Eckpunkte des Reviews definiert:

- Fragestellung (PECO Kriterien[1])
- Suchbereiche (Datenbanken, Internet generell, Websites relevanter Organisationen)
- Suchbegriffe
- Restriktionen
- Eignungskriterien (Ein- und Ausschlusskriterien)
- Protokolle für Dokumentation, Tabellen für Datenextraktion
- Review-Team, Zeitrahmen, Werkzeuge (wie Referenz- oder Review Manager)

3.1 Suchstrategie

3.1.1 Fragestellung

Die primäre Fragestellung des Reviews lässt sich dem PECO Typ (Higgins und Green, 2011) zuordnen und lautet:

Inwiefern sind

- (P=Population) bei Menschen im Lebensalter über 60 Jahren durch
  - physiologische/psychische Veränderungen im Alter oder
  - eine stärkere Exposition oder
  - Schadstoffakkumulationen über die Lebensjahre oder
  - soziodemografische Faktoren
- (E=Exposition) gegenüber Umwelteinflüssen durch ***Luftbelastungen***, ***Lärm***, ***Chemikalien*** und dem ***Klimawandel***
- (C=Comparator) im Vergleich zu jüngeren Altersgruppen/weniger bzw. nicht exponierten Menschen
- (O=Outcome) gesundheitlich nachteilige Auswirkungen oder höhere Belastungen der Gesundheitsinfrastruktur

nachgewiesen (Tabelle 2)?

Sekundäre Fragen sind:

- Welchen Umwelteinflüssen kommt dabei die größte Relevanz zu?

[1] Um die Studienfrage eines Systematic oder Scoping Review (Tabelle 1, Zeile 1) möglichst konkret zu formulieren und die daraus hervorgehenden Ergebnisse möglichst gut nutzbar zu machen, erfolgt die Formulierung nach dem PECO Schema. PECO ist ein Akronym und steht für Population – untersuchte Population, Exposition – Aussetzung, Comparison – Alternativaussetzung oder keine Aussetzung, Outcome - Ergebnis (z.B. Mortalität, Morbidität).

- Welche Unterschiede lassen sich innerhalb der Gruppe der älteren Menschen erkennen (z. B. in Bezug auf Geschlecht, Altersgruppe, soziodemografische Merkmale)?

Tabelle 2: Schlüsselelemente und Kriterien zur Definition der Suchfrage

Schlüsselelemente	Kriterien	Spezifikation
Population	ältere Menschen (über 60 Jahre)	physiologischer/psychischer Status Exposition Schadstoffkonzentrationen im Körper soziodemografische Faktoren
Exposition Luftbelastungen (Außenluft und Innenraumluft)	Belastungen und Auswirkungen durch Luftbelastungen im Innen- und Außenraum, z. B. durch Bauprodukte und Ausstattungsgegenstände sowie durch Verkehr, Industrie	Benzol (C_6H_6), Bioaerosole, Feinstaub (PM10, PM2.5, ultrafeine Partikel (UFP), flüchtige organische Verbindungen (SVOC, VOC, VVOC), Ozon (O_3), Stickstoffdioxid (NO_2), Schwermetalle
Exposition Klimawandel	Gesundheitsrelevante Auswirkungen des Klimawandels durch Extremwetterereignisse wie Hitze und Starkregen	Hitzebelastungen (z. B. Hitzeperioden, sehr heiße Tage, Tropennächte), Stürme, Starkregen Hochwasser, Überflutung
Exposition Lärm	Gesundheitsrelevante Lärmbelastungen durch Umgebungslärm	Industrielärm, Verkehrslärm, Freizeit- und Nachbarschaftslärm
Exposition Chemikalien	Gesundheitsrelevante Chemikalienbelastungen, z. B. durch Schwermetalle, organische Verbindungen, Weichmacher aus Kunststoffen	Arsen (As), Bisphenol A (BPA), per- und polyfluorierte Chemikalien (PFCs/PFAS), persistente organische Schadstoffe (POP), polychlorierte Biphenyle (PCBs), Schwermetalle, Weichmacher/Phthalate
Comparator	jüngere Menschen (unter 60 Jahre)	physiologischer/psychischer Status Exposition Schadstoffkonzentrationen im Körper soziodemografische Faktoren
Comparator	ältere Menschen (über 60 Jahre)	physiologischer/psychischer Status keine Exposition

Schlüsselelemente	Kriterien	Spezifikation
		Schadstoffkonzentrationen im Körper soziodemografische Faktoren
Outcomes	Vulnerabilität (Wahrscheinlichkeit einer ungewöhnlich starken gesundheitlich nachteiligen Wirkung, entweder aufgrund einer besonderen Anfälligkeit oder als Folge einer überdurchschnittlichen Exposition)	Gesundheitliche Auswirkungen (Morbidität und Mortalität) Auswirkungen auf Gesundheitsinfrastruktur (Notfalleinsätze der Rettungsdienste, Krankenhausaufnahmen)

3.1.2 Suchbereiche

3.1.2.1 Literatur-Datenbanken

Folgende Literaturdatenbanken wurden für die Recherche im Rahmen des Vorhabens herangezogen.

3.1.2.1.1 Multidisziplinäre Literaturdatenbanken

- Scopus (Elsevier, New York, USA)

  Scopus ist eine multidisziplinäre Abstract- und Zitationsdatenbank für Forschungsliteratur und hochwertige Internet-Quellen (peer-reviewed). Zur Verfügung stehen verschiedene Tools zur Verfolgung, Analyse und Visualisierung von Forschungsinformationen aus allen Fachgebieten, wie z. B. Naturwissenschaften, Technik, Medizin und Gesundheitswissenschaften, Sozialwissenschaften sowie Kunst- und Geisteswissenschaften.

  Scopus liefert zudem die Zitierungen der wissenschaftlichen Artikel (References und Citations), die die Zitationsanalyse ermöglichen (ab dem Publikationsjahr 1996).

- Web of Science (Clarivate Analytics, Philadelphia, USA)

  Das Web of Science ist eine Rechercheoberfläche, in der in verschiedenen Literatur- und Zitationsdatenbanken nach relevanter wissenschaftlicher Literatur gesucht werden kann. Web of Science liefert auch die Zitierungen der wissenschaftlichen Artikel (References und Citations), die die Zitationsanalyse ermöglichen.

  Die Web of Science Plattform hat den Vorteil der Interdisziplinarität, also des breiten Fächerspektrums von Medizin, Natur-, Geistes-, Sozial- und Wirtschaftswissenschaften.

3.1.2.1.2 Fachspezifische Literaturdatenbanken

Die Suche in fachspezifischen Literaturdatenbanken erfolgte über das Portal LIVIVO (ZB MED - Informationszentrum Lebenswissenschaften). LIVIVO ist eine interdisziplinäre Suchmaschine für Literatur und Informationen zu den Lebenswissenschaften. LIVIVO enthält u.a. eine vollständige Recherche in folgenden Datenquellen:

- BASE (Bielefeld Academic Search Engine),

- Bibliothek des Bundesinstituts für Risikobewertung (BfR),
- Bibliothek des Bundesamtes für Verbraucherschutz und Lebensmittelsicherheit (BVL),
- Katalog der US National Library of Medicine (NLM),
- Katalog der Technischen Informationsbibliothek (TIP), Hannover),
- Katalog "Lebenswissenschaften: Medizin, Gesundheitswesen, Ernährungs-, Umwelt- und Agrarwissenschaften" des ZB MED – Informationszentrums Lebenswissenschaften,
- MEDLINE,
- PSYNDEX,
- SOMED (SOzialMEDizin, Gesundheitswissenschaften und Public Health),
- Umweltforschungsdatenbank UFORDAT des Umweltbundesamtes (UBA).

3.1.2.2 Internet/graue Literatur

In Google und Google Scholar wurden - soweit vorhanden - jeweils die ersten 50 Treffer jeder spezifischen Suchanfrage (s. A. Tabelle 33 und Tabelle 34) auf Relevanz geprüft.

3.1.2.3 Manuelle/Vorwärts- Rückwärtssuche

In der Masterarbeit von Vahle (2012) wurde der Text und die Referenzliste nach weiteren relevanten Veröffentlichungen/Studien durchsucht.

3.1.3 Suchbegriffe

Zur Identifizierung von Suchbegriffen erfolgte ein Screening für den Themenkomplex Lärm. 26 initial, durch einfache Suche über Google Scholar identifizierte Publikationen zu Gesundheitsauswirkungen auf Lärm wurden auf Schlüsselwörter zur Beschreibung der Population, der Exposition und der untersuchten Auswirkungen analysiert. Dazu wurden die in den Publikationen benutzten Begriffe zu Populationen und Expositionen in einer Tabelle extrahiert und auf Synonyme (insbesondere für „ältere Menschen“) sowie Relevanz analysiert. Aus dieser Analyse wurden dann die Suchbegriffe abgeleitet.

Die in der Suche für alle vier Bereiche der Umweltbelastungen eingesetzten Suchbegriffe sind in Anhang A.1dargestellt.

Die Suche erfolgte ausschließlich mit englischsprachigen Suchbegriffen.

3.2 Einschlusskriterien und Selektion

Die Selektion relevanter Publikationen auf die Einhaltung der Einschlusskriterien (Tabelle 3) erfolgte in zwei Stufen:

- Sichtung der Titel und Abstracts
- Sichtung der Volltexte

Tabelle 3: Einschlusskriterien und Beschreibung

Konzept/Schlüsselelemente	Einschlusskriterien	Eignung
Population	Alter	mindestens 60 Jahre und exponiert
Exposition	Umweltbelastungen	Luftbelastungen in Außen- und Innenraumluft, Klimawandel, Lärm, Chemikalien spezifiziert
Comparator	Alter	unter 60 Jahre und exponiert/mindestens 60 Jahre und nichtexponiert
Outcome	Gesundheitliche Auswirkungen Auswirkungen auf Gesundheitsinfrastruktur (Notfalleinsätze der Rettungsdienste, Krankenhausaufnahmen)	Morbidität (Prävalenz, Inzidenz) oder Mortalität spezifiziert, Krankheiten spezifiziert Gesundheitsinfrastrukturdaten spezifiziert
Publikation	Format	Artikel = wissenschaftliche Publikation, Bericht, Datenbankbericht Veröffentlichung zu Originaldaten keine Konferenzbeiträge, keine Reviews, keine Vorträge, keine Internetdokumente, keine Editorials, keine Letter
Publikation	Sprache	Englisch, Deutsch
Publikation	Datum der Veröffentlichung	nach 2003
Publikation	Zugriff	Volltext/Datendetails verfügbar
Informationen/Datenanforderungen	untersuchte Populationsfaktoren	Altersgruppen (ältere-jüngere Menschen) differenziert
Art der Studie	Typ	epidemiologische Studien (Beobachtungsstudien, Querschnittsstudien, Kohortenstudien, Fall-Kontrollstudien, ökologische Studien) keine Tierstudien (Laborexperimente, toxikologische Studien)

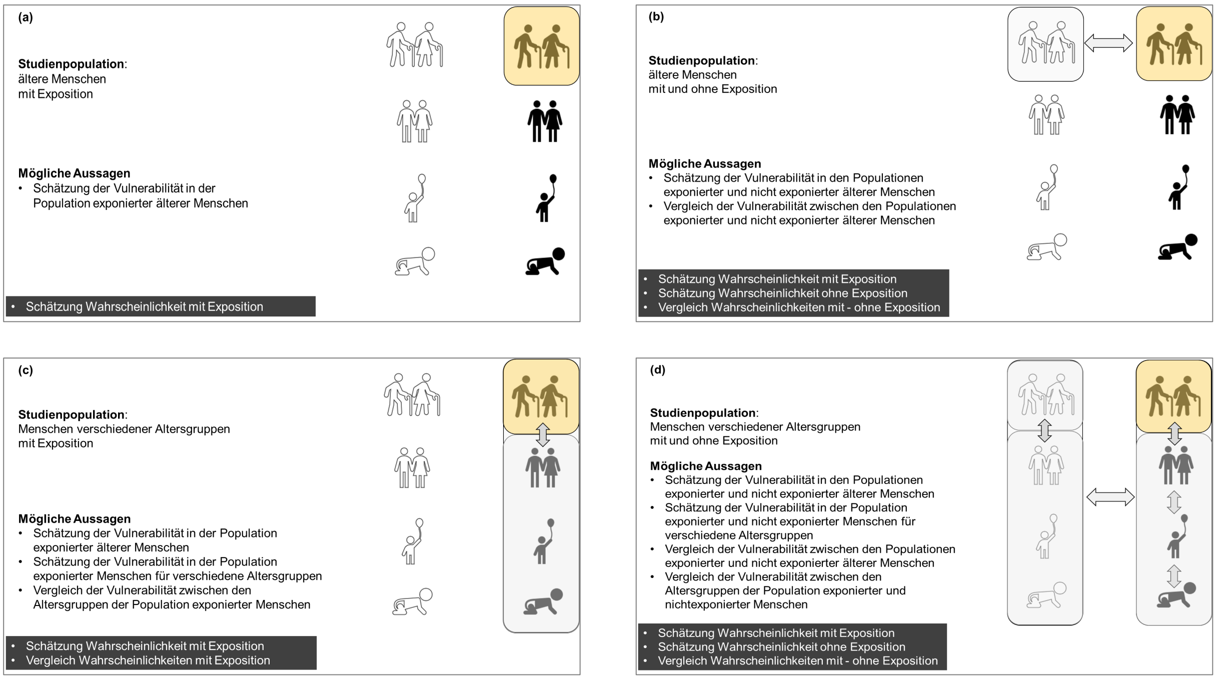
In den Review eingeschlossen wurden Studien, die die Population älterer Menschen als Gruppe berücksichtigten. Hierfür kommen verschiedene Studiendesigns infrage (Abbildung 2):

- ältere Menschen mit Exposition (a),
- ältere Menschen mit und ohne Exposition (b),
- Menschen verschiedener Altersgruppen mit Exposition (c),

- Menschen verschiedener Altersgruppen mit und ohne Exposition (d).

In den eingeschlossenen Studien wurde die Morbidität (anhand der Prävalenz oder Inzidenz von Erkrankungen oder Veränderungen der Vitalparameter der Studienteilnehmenden), die Mortalität (anhand der Häufigkeit von Todesfällen) und/oder die Auswirkungen auf die Gesundheitsinfrastruktur (anhand der Häufigkeit von Notrufen, Notfalleinsätzen oder Krankenhausweinweisungen) ermittelt und ggf. verglichen.

Abbildung 2: Studiendesigns zur Erfassung der Vulnerabilität älterer Menschen



Quelle: eigene Darstellung BioMath GmbH

3.3 Datenextraktion und Dokumentation

Alle Suchergebnisse wurden im Referenzmanagementsystem Citavi 6.0 abgelegt.

Die bibliografischen Daten, Ein- und Ausschlusskriterien und weitere Charakteristika wurden sukzessive aus der recherchierten Literatur extrahiert und wie folgt tabellarisch dokumentiert.

1. Zunächst wurden die wichtigsten bibliografischen Daten aus dem Referenzmanagementsystem exportiert.

   AutorInnen, HerausgeberInnen, Jahr, Titel, Abstract

   Dokumententyp

   DOI, Zeitschrift/Zeitung, Band, Nummer, Online-Adresse

   Zusätzlich wurde das Land, in dem die Studie durchgeführt wurde, identifiziert.

2. Anschließend erfolgte eine Extraktion der Informationen basierend auf den Einschlusskriterien (s. 3.2).
3. Anhand der extrahierten Informationen fand eine Selektion von Studien statt. Nicht relevante Publikationen wurden unter Angabe folgender Gründe ausgeschlossen (Tabelle 4).

Tabelle 4: Ausschlussgründe und Code

Ausschlussgrund	Code
kein (Einschluss)	0
Duplikat	1
nicht erfüllt: Population - Alter mindestens 60 Jahre	2
nicht erfüllt: Exposition - Umweltbelastungen (Luftbelastungen in Außen- und Innenraumluft, Klimawandel, Lärm, Chemikalien wie spezifiziert)	3
nicht erfüllt: Outcome - Gesundheitliche Auswirkungen: Morbidität (Prävalenz, Inzidenz) oder Mortalität spezifiziert, Krankheiten spezifiziert/Auswirkungen auf Gesundheitsinfrastruktur (Notfalleinsätze der Rettungsdienste, Krankenhausaufnahmen)	4
nicht erfüllt: Studientyp - epidemiologische Studien (Beobachtungsstudien, Querschnittsstudien, Kohortenstudien, Fall-Kontrollstudien, ökologische Studien), keine Tierstudien (Laborexperimente, toxikologische Studien)	5
nicht erfüllt: Sprache - Englisch, Deutsch	6
nicht erfüllt: Publikation - Artikel = wissenschaftliche Publikation, Bericht, Datenbankbericht, Datum der Veröffentlichung nach 2003, Volltext/Datendetails verfügbar	7

4. Die selektierten Publikationen wurden in einem vierten Schritt nach Exposition und Outcome gruppiert. Dabei wurden die Angaben zur Exposition klassifiziert nach den in Tabelle 2, Spalte 3 angegebenen Spezifikationen. Die Angaben zum Outcome wurden klassifiziert nach Morbidität, Mortalität und den Auswirkungen auf die Gesundheitsinfrastruktur (Art). Die untersuchten Krankheiten wurden nach ICD-10-GM[2] (Internationale statistische Klassifikation der Krankheiten und verwandter Gesundheitsprobleme, Deutsches Institut für Medizinische Dokumentation und Information, DIMDI) klassifiziert (Unterart, s. Tabelle 5).

Tabelle 5: Klassifizierung der untersuchten Auswirkungen (Outcome)

Art	Unterart
Morbidität/Mortalität	
	Bestimmte infektiöse und parasitäre Krankheiten
	Neubildungen
	Krankheiten des Blutes und der blutbildenden Organe sowie bestimmte Störungen mit Beteiligung des Immunsystems
	Endokrine, Ernährungs- und Stoffwechselkrankheiten
	Psychische und Verhaltensstörungen
	Krankheiten des Nervensystems
	Krankheiten des Auges und der Augenanhangsgebilde

[2] wichtigstes, weltweit anerkanntes Klassifikationssystem für medizinische Diagnosen, deutsche Version https://www.dimdi.de/dynamic/de/klassifikationen/icd/icd-10-gm/

Art	Unterart
	Krankheiten des Ohres und des Warzenfortsatzes
	Krankheiten des Kreislaufsystems
	Krankheiten des Atmungssystems
	Krankheiten des Verdauungssystems
	Krankheiten der Haut und der Unterhaut
	Krankheiten des Muskel-Skelett-Systems und des Bindegewebes
	Krankheiten des Urogenitalsystems
	Schwangerschaft, Geburt und Wochenbett
	Bestimmte Zustände, die ihren Ursprung in der Perinatalperiode haben
	Angeborene Fehlbildungen, Deformitäten und Chromosomenanomalien
	Symptome und abnorme klinische und Laborbefunde, die anderenorts nicht klassifiziert sind
	Verletzungen, Vergiftungen und bestimmte andere Folgen äußerer Ursachen
	Äußere Ursachen von Morbidität und Mortalität
	Faktoren, die den Gesundheitszustand beeinflussen und zur Inanspruchnahme des Gesundheitswesens führen
	Schlüsselnummern für besondere Zwecke
Gesundheitsinfrastruktur	
	Krankenhauseinweisungen
	Notaufnahmebesuche
	Notrufe

Damit konnte jede Studie einer Exposition – Outcome-Gruppe zugeordnet werden.

5. Für die selektierten Publikationen erfolgte die Extraktion der Ergebnisse und die Bewertung der Qualität (s. Kapitel 3.4).
6. Für jede Kombination nach Exposition und Outcome (Unterart) erfolgte eine Zusammenfassung der Ergebnisse und Qualität der Studien (s. Kapitel 3.5).

Alle identifizierten (ein- und ausgeschlossenen) Publikationen sowie die extrahierten Informationen zu den Einschlusskriterien, den Ergebnissen und der Qualität sind in Excel-Tabellen abgelegt. Über die extrahierten Daten (z. B. zu Exposition und Outcome) kann in den finalen Publikationstabellen eine Sortierung/Selektion erfolgen.

3.4 Bewertung der identifizierten Studien

3.4.1 Ergebnisbewertung

Die Ergebnisse wurden je nach ihrer Bewertung der Vulnerabilität älterer Menschen in drei Kategorien eingeteilt:

- erhöhte Vulnerabilität (+): exponierte ältere Menschen sind vulnerabler im Vergleich zu nicht exponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen,
- gleiche Vulnerabilität (0): keine Unterschiede zwischen den untersuchten Gruppen,
- geringere Vulnerabilität (-): exponierte ältere Menschen sind weniger vulnerabel im Vergleich zu nicht exponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen.

3.4.2 Qualitätsbewertung

Im Hinblick auf den Hintergrund des Projektes erfolgte angelehnt an die OHAT-Leitlinie (Office of Health Assessment and Translation (OHAT) 2019), eine initiale Qualitätsbenotung. Die OHAT-Leitlinie orientiert sich an den GRADE-Leitlinien (Schünemann et al. 2008; Atkins et al. 2004), ist aber für die Bewertung potentieller Auswirkungen von Umweltchemikalien oder physikalischen Substanzen auf die menschliche Gesundheit adaptiert und wird in diesem Bereich vielfach eingesetzt. Die Qualitätsbeurteilung erfolgte auf einer Skala (+ sehr niedrig, ++ niedrig, +++ moderat, ++++ hoch), die sich als Summenscore aus vier Studiendesign-Kriterien ergibt

- Der Studientyp ist angegeben und es wurde mindestens eine Kohorten-/Fall-Kontroll- oder Querschnittsstudie durchgeführt.
- Die Exposition hat kontrolliert und zeitlich vor dem Outcome stattgefunden.
- Der Outcome wurde an einzelnen Individuen erhoben.
- Es ist eine Vergleichsgruppe vorhanden.

3.5 Deskriptive Auswertung und narrative Beschreibung der Studienergebnisse

Für jeden der vier Umwelteinflüsse (Chemikalien, Klimawandel, Lärm, Luftbelastungen) erfolgte eine

- grafische und tabellarische Darstellung der Durchführungsorte der Studien,
- deskriptive Darstellung der Anzahl von Studien je Exposition – Outcome Kombination,
- deskriptive Darstellung der Ergebnisbewertungen der Studien und
- deskriptive Auswertung der Qualitätsbewertungen der Studien.

Für jede Studie wurden die für die Population älterer Menschen getroffenen Aussagen extrahiert und diese dann je Exposition-Outcome-Kombination (z. B. Verkehrslärm und – Erkrankungen des Herz- und Kreislaufsystems) narrativ zusammengefasst (s. Kapitel 4.2.1).

4 Ergebnisse

4.1 Dokumentation der Suche

4.1.1 Ablauf der Suche

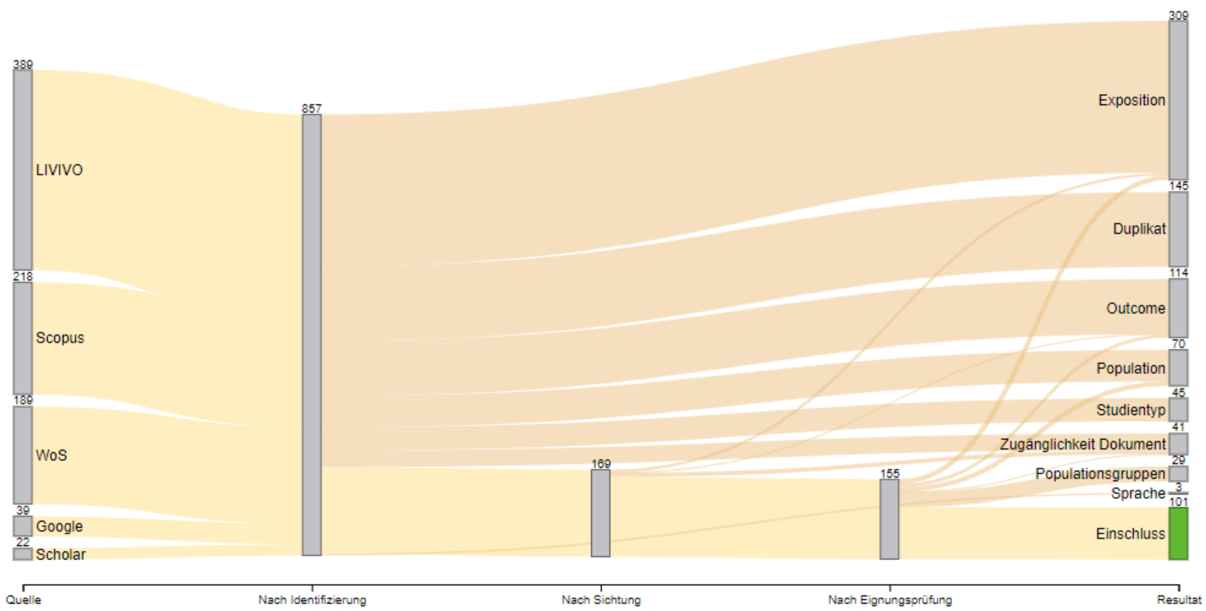
Die Suche in Web of Science und Scopus erfolgte am 14.11.2018, in LIVIVO am 26.11.2018 und in Google und Google Scholar im Zeitraum Januar bis März 2019. Die Suche ist im Anhang A.2 protokolliert.

4.1.2 Suchergebnisse und Selektion

4.1.2.1 Exposition: Chemikalien

Für das Themenfeld Chemikalien wurden in den fünf verschiedenen Suchbereichen (Scopus, Web of Science, LIVIVO, Google und Google Scholar) insgesamt 857 Publikationen identifiziert. Im ersten Schritt der Selektion (Sichtung der Titel und Abstracts) wurden 688 Publikationen und im zweiten Schritt (Sichtung der Volltexte) noch einmal 68 Publikationen ausgeschlossen (Duplikate: 145, Nichteinhaltung der Einschlusskriterien Population: 99, Exposition: 309, Outcome: 114, Studientyp: 45, Sprache: 3, Dokumentenzugänglichkeit: 41). Der Selektionsprozess ist in Abbildung 3 dargestellt. Abschließend wurden 101 Publikationen in die Ergebnis- und Qualitätsbewertung eingeschlossen.

Abbildung 3: Sankey-Diagramm des Review-Prozesses zur Exposition Chemikalien



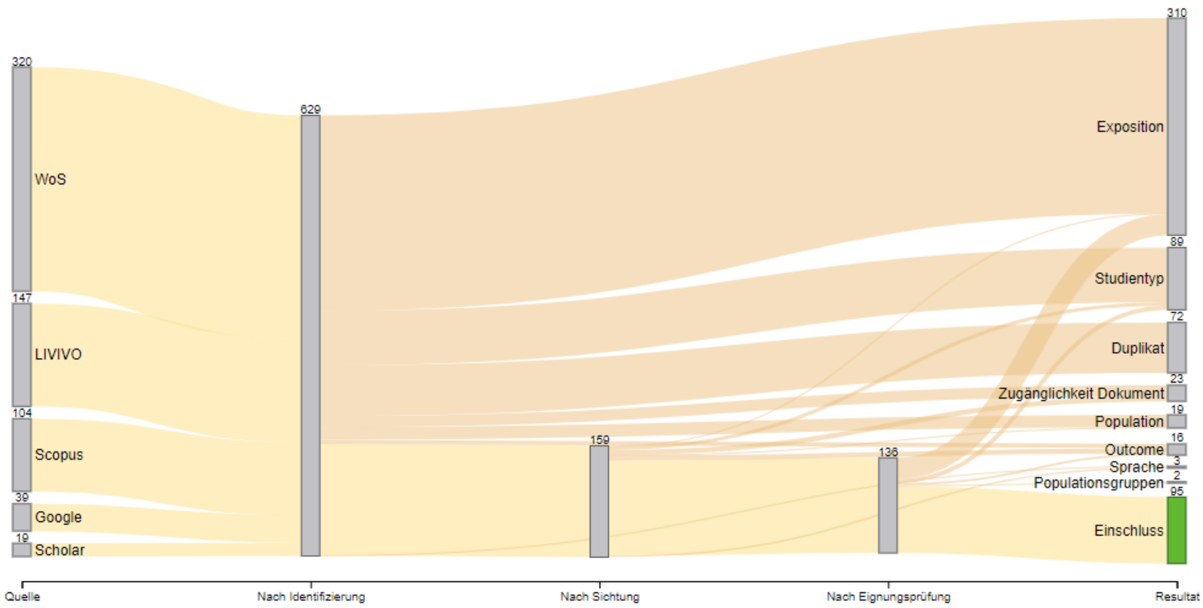
Die Dicke der Pfeile (Flussmengen) ist proportional zur Anzahl der Studien.

Quelle: eigene Darstellung BioMath GmbH

4.1.2.2 Exposition: Klimawandel

Für das Themenfeld Klimawandel wurden in den fünf verschiedenen Suchbereichen (Scopus, Web of Science, LIVIVO, Google und Google Scholar) insgesamt 629 Publikationen identifiziert. Im ersten Schritt der Selektion (Sichtung der Titel und Abstracts) wurden 470 Publikationen und im zweiten Schritt (Sichtung der Volltexte) noch einmal 64 Publikationen ausgeschlossen (Duplikate: 72, Nichteinhaltung der Einschlusskriterien Population: 21, Exposition: 310, Outcome: 16, Studientyp: 89, Sprache: 3, Dokumentenzugänglichkeit: 23). Der Selektionsprozess ist in Abbildung 4 dargestellt. Abschließend wurden 95 Publikationen in die Ergebnis- und Qualitätsbewertung eingeschlossen.

Abbildung 4: Sankey-Diagramm des Review-Prozesses zur Exposition Klimawandel



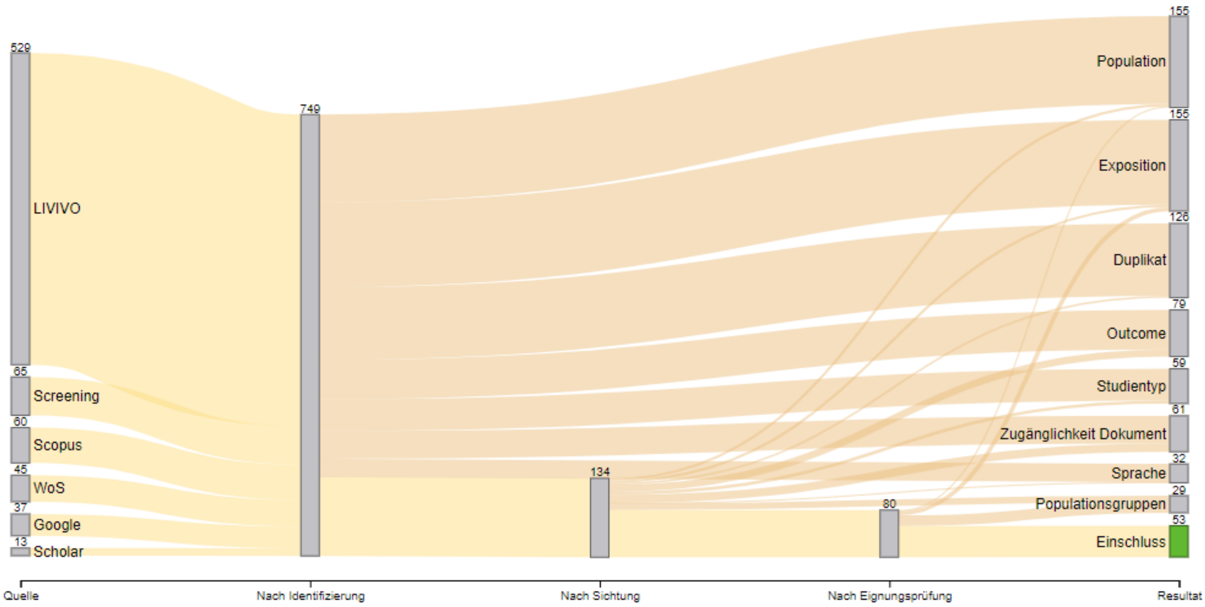
Die Dicke der Pfeile (Flussmengen) ist proportional zur Anzahl der Studien.

Quelle: eigene Darstellung BioMath GmbH

4.1.2.3 Exposition: Lärm

Für das Themenfeld Lärm wurden in den fünf verschiedenen Suchbereichen (Scopus, Web of Science, LIVIVO, Google und Google Scholar) insgesamt 749 Publikationen identifiziert. Im ersten Schritt der Selektion (Sichtung der Titel und Abstracts) wurden 615 Publikationen und im zweiten Schritt (Sichtung der Volltexte) noch einmal 81 Publikationen ausgeschlossen (Duplikate: 126, Nichteinhaltung der Einschlusskriterien Population: 184, Exposition: 155, Outcome: 79, Studientyp: 59, Sprache: 32, Dokumentenzugänglichkeit: 61). Der Selektionsprozess ist in Abbildung 5 dargestellt. Abschließend wurden 53 Publikationen in die Ergebnis- und Qualitätsbewertung eingeschlossen.

Abbildung 5: Sankey-Diagramm des Review-Prozesses zur Exposition Lärm

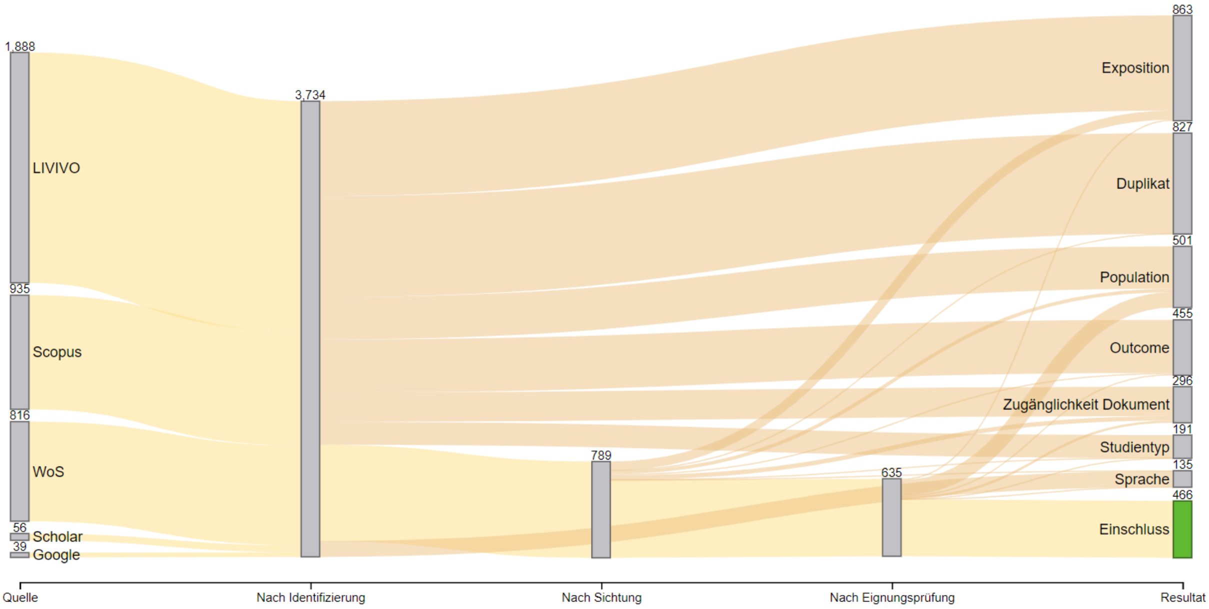


Die Dicke der Pfeile (Flussmengen) ist proportional zur Anzahl der Studien.
Quelle: eigene Darstellung BioMath GmbH

4.1.2.4 Exposition: Luftbelastungen

Für das Themenfeld Luftbelastungen wurden in den fünf verschiedenen Suchbereichen (Scopus, Web of Science, LIVIVO, Google und Google Scholar) insgesamt 3.734 Publikationen identifiziert. Im ersten Schritt der Selektion (Sichtung der Titel und Abstracts) wurden 2.945 Publikationen und im zweiten Schritt (Sichtung der Volltexte) noch einmal 322 Publikationen ausgeschlossen (Duplikate: 827, Nichteinhaltung der Einschlusskriterien Population: 500, Exposition: 863, Outcome: 455, Studientyp: 191, Sprache: 135, Dokumentenzugänglichkeit: 296). Der Selektionsprozess ist in Abbildung 6 dargestellt. Abschließend wurden 466 Publikationen in die Ergebnis- und Qualitätsbewertung eingeschlossen.

Abbildung 6: Sankey-Diagramm des Review-Prozesses zur Exposition Luftbelastungen



Die Dicke der Pfeile (Flussmengen) ist proportional zur Anzahl der Studien.
Quelle: eigene Darstellung BioMath GmbH

4.1.2.5 Zusammenfassung

Tabelle 6 stellt die Anzahl identifizierter sowie aus- und eingeschlossener Publikationen in den einzelnen Review-Schritten dar.

Tabelle 6: Anzahl Publikationen in den einzelnen Review Phasen

	Exposition				
	Chemikalien	Klimawandel	Lärm	Luftbelastungen	Gesamt
Suche					
Google	39	39	37	39	154
Scholar	22	19	13	56	110
LIVIVO	389	147	529	1.888	2.953
Scopus	218	104	60	935	1.317
Screening[3]			65		65
WoS	189	320	45	816	1.370
Total	**857**	**629**	**749**	**3.734**	**5.969**
Sichtung Titel, Abstracts					

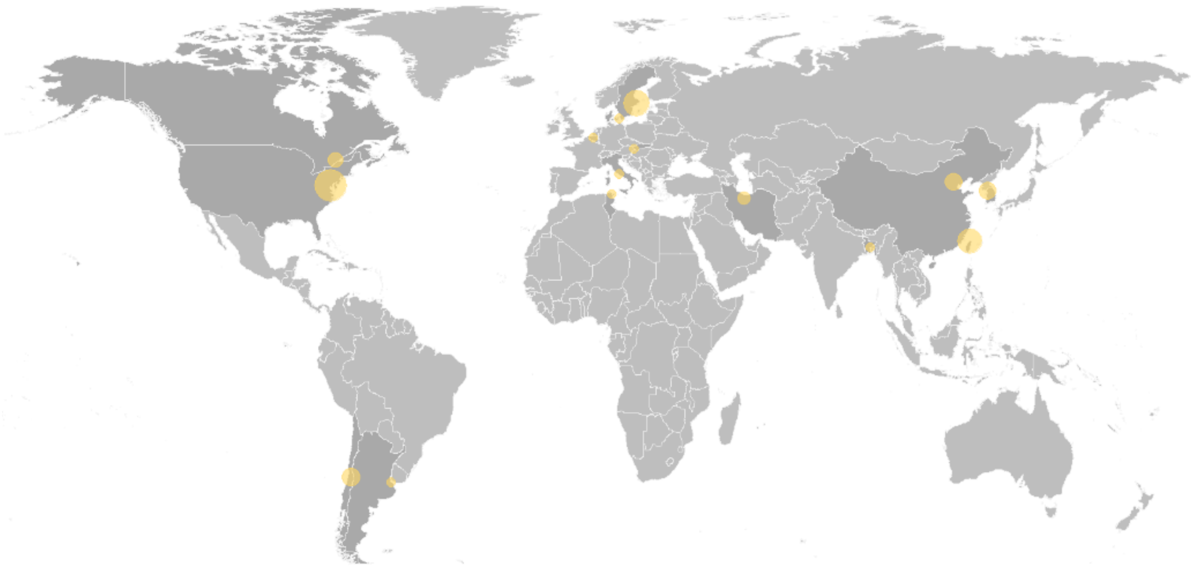
[3] Zur Identifizierung von Suchbegriffen erfolgte ein Screening für den Themenkomplex Lärm (s. Kapitel 3.1.3)

	Exposition				
Ausschluss	**688**	**470**	**615**	**2.945**	**4.718**
1 Doppel	145	72	123	826	1.166
2 Population	61	18	149	347	575
3 Exposition	295	279	144	779	1.497
4 Outcome	107	6	67	435	615
5 Studientyp	45	78	54	187	364
6 Sprache	3	1	31	130	165
7 Dokument Zugänglichkeit	32	16	47	241	336
Einschluss	**169**	**159**	**134**	**789**	**1.251**
Sichtung Volltexte					
Ausschluss	**68**	**64**	**81**	**322**	**535**
1 Doppel	0	0	3	1	4
2 Population	38	3	35	152	229
3 Exposition	14	31	11	84	140
4 Outcome	7	10	12	20	49
5 Studientyp	0	11	5	4	20
6 Sprache	0	2	1	5	8
7 Dokument Zugänglichkeit	9	7	14	55	85
Einschluss	**101**	**95**	**53**	**466**	**715**

4.2 Vulnerabilität gegenüber Umwelteinflüssen durch Chemikalien

Insgesamt wurden 101 Studien (bzw. Publikationen) identifiziert, die sich mit der Vulnerabilität älterer Menschen gegenüber Umwelteinflüssen durch Chemikalien beschäftigen, davon 42 % in Amerika, 29 % in Asien und 23 % in Europa. Allein 33 Studien wurden in den USA, 19 Studien in Schweden und 16 Studien in Taiwan durchgeführt (Abbildung 7, Tabelle 7).

Abbildung 7: Orte der Durchführung der Studien zu Umwelteinflüssen durch Chemikalien



Die Größe der Kreise ist proportional zur Anzahl der Studien. Der Mittelpunkt der Kreise liegt jeweils auf den Koordinaten der Landeshauptstadt.
Quelle: eigene Darstellung BioMath GmbH

Tabelle 7: Orte der Durchführung der Studien zu Umwelteinflüssen durch Chemikalien

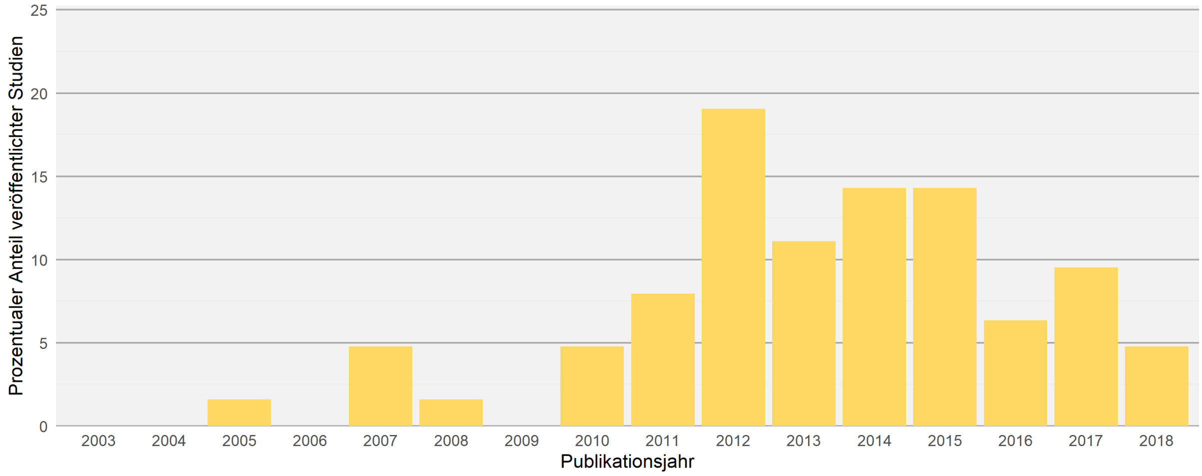
Region (Land)	Anzahl
Afrika (Tunesien: 1)	1
Amerika (Argentinien: 1, Chile: 6, Kanada: 3, USA: 33)	43
Asien (Bangladesch: 1, China: 5, Iran: 2, Taiwan: 16, Korea: 5)	34
Europa (Belgien: 1, Dänemark: 1, Italien: 1, Schweden: 19, Slowakei: 1)	23
Ozeanien	0
k. A.	5
Total	**101**

Die Veröffentlichung der Studien war gemäß Suchprotokoll zwischen 2003 und 2018 mit einer deutlichen Zunahme der Anzahl nach 2010 (Tabelle 8, Abbildung 8).

Tabelle 8: Jahr der Veröffentlichung der Studien zu Umwelteinflüssen durch Chemikalien

Jahr	Anzahl		Jahr	Anzahl		Jahr	Anzahl		Jahr	Anzahl
2003	0		2007	3		2011	5		2015	9
2004	0		2008	1		2012	12		2016	4
2005	1		2009	0		2013	7		2017	6
2006	0		2010	3		2014	9		2018	3

Abbildung 8: Jahr der Veröffentlichung der Studien zu Umwelteinflüssen durch Chemikalien



Quelle: eigene Darstellung BioMath GmbH

In den 101 Studien wurden die Auswirkungen von Arsen, Bisphenol A, per- und polyfluorierten Chemikalien, polychlorierten Biphenylen, Schwermetallen, Weichmachern/Phthalaten und persistenten organischen Schadstoffen auf Morbidität und Mortalität betrachtet (Tabelle 9).

Tabelle 9: Anzahl identifizierter Studien zu Vulnerabilität (Outcome) bei Belastungen durch Chemikalien (Exposition)

	Exposition							
Outcome	**Arsen[1]**	**Bisphenol A**	**per- und polyfluorierte Chemikalien**	**polychlorierte Biphenyle**	**Schwermetalle[1]**	**Weichmacher/Phthalate**	**persistente organische Schadstoffe**	**Gesamtergebnis**
Morbidität	**25**	**7**	**8**	**8**	**8**	**7**	**19**	**82**
C00-D48 Neubildungen	13		1	4	1			19
D50-D90 Krankheiten des Blutes und der blutbildenden Organe sowie bestimmte Störungen mit Beteiligung des Immunsystems							1	1
E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten	1	2	6	2	2	2	6	21
F00-F99 Psychische und Verhaltensstörungen	2			1	1	1	1	6
G00-G99 Krankheiten des Nervensystems				1			1	2
I00-I99 Krankheiten des Kreislaufsystems	5	5	1		4	1	6	21
J00-J99 Krankheiten des Atmungssystems						1		1
K00-K93 Krankheiten des Verdauungssystems							1	1

	Exposition							
Outcome	**Arsen[1]**	**Bisphenol A**	**per- und polyfluorierte Chemikalien**	**polychlorierte Biphenyle**	**Schwermetalle[1]**	**Weichmacher/Phthalate**	**persistente organische Schadstoffe**	**Gesamtergebnis**
L00-L99 Krankheiten der Haut und der Unterhaut	1							1
N00-N99 Urogenitalsystem	2							2
R00-R99 Symptome und abnorme klinische und Laborbefunde, die anderenorts nicht klassifiziert sind						2	1	3
S00-T98 Verletzungen, Vergiftungen und bestimmte andere Folgen äußerer Ursachen								1
Diverse*	1						2	4
Mortalität	**12**		**1**				**6**	**19**
C00-D48 Neubildungen	3							5
I00-I99 Krankheiten des Kreislaufsystems	3						1	4
J00-J99 Krankheiten des Atmungssystems	1							1
K00-K93 Krankheiten des Verdauungssystems							1	1
Diverse*	5		1				4	15
Gesamtergebnis	**37**	**7**	**9**	**8**	**8**	**7**	**25**	**101**

* Studien, die mindestens zwei Themenschwerpunkte/Outcomes enthalten (Bsp.: C00-D48 Neubildungen; E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten; I00-I99 Krankheiten des Kreislaufsystems)

[1] Enthält Studienergebnisse, die sich vorrangig auf Entwicklungs-/Schwellenländer konzentrieren mit Schwerpunkten, die nicht für die Fragestellung zur Exposition relevant sind. Diese Publikationen wurden nicht in der narrativen Analyse berücksichtigt.

Die 37 Studien zu Arsen wurden nicht weiter in der Ergebnis- und Qualitätsbewertung sowie der narrativen Analyse berücksichtigt, da die Studien sich vorrangig auf Entwicklungs-/Schwellenländer konzentrieren mit Schwerpunkten, die nicht für Mitteleuropa/Deutschland relevant sind. Von den restlichen 63 Studien stellten 49 (78 %) eine erhöhte Vulnerabilität exponierter älterer Menschen im Vergleich zu nichtexponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen fest, 14 Studien (22 %) fanden keine Unterschiede (Tabelle 10).

Tabelle 10: Ergebnisse der Studien zu Umwelteinflüssen durch Chemikalien

Effekt	Code	Anzahl
Exponierte ältere Menschen sind vulnerabler im Vergleich zu nichtexponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen	+	49
Keine Unterschiede zwischen den untersuchten Gruppen	0	14
Exponierte ältere Menschen sind weniger vulnerabel im Vergleich zu nichtexponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen	-	0

Eine Studie konnte mit dem höchsten Summenqualitätsscore ++++ bewertet werden. 11 Studien wurden mit +++ bewertet, wobei bei keiner dieser Studien eine kontrollierte Exposition vorlag. 37 Studien erhielten den Gesamtscore ++, hier fehlte in der Regel die Vergleichsgruppe. 14 Studien erhielten den Gesamtscore + (Tabelle 11). Verständlicherweise ist die kontrollierte Exposition das Qualitätskriterium, das von den wenigsten Studien erfüllt wird.

Tabelle 11: Qualität der Studien zu Umwelteinflüssen durch Chemikalien

	Qualitätskriterium				
Kombinationsscore	**Studientyp**	**kontrollierte Exposition**	**Einzeldaten**	**Vergleichsgruppe**	**Anzahl Studien**
++++	+	+	+	+	**1**
+++	-	+	+	+	**1**
+++	+	-	+	+	**10**
++	-	-	+	+	**23**
++	+	-	+	-	**14**
+	-	-	+	-	**14**
Anzahl Studien, die das Qualitätskriterium erfüllen (+)	**25**	**2**	**63**	**35**	**63**

Im Folgenden wird eine Zusammenfassung der Ergebnisse gegeben. Einzelheiten zu jeder Studie inklusive Ergebnis- und Qualitätsbewertung finden sich im Anhang B.1.

4.2.1 Neubildungen

Ducatman et al. (2015) finden keine Zusammenhänge zwischen der Exposition gegenüber per- und polyfluorierten Chemikalien in der männlichen älteren Bevölkerung (50-69 Jahre) und dem prostata-spezifischen Antigen. Raleigh et al. (2014) finden bei Personen über 60-Jahren keine Assoziation zwischen beruflicher Exposition mit per- und polyfluorierten Chemikalien und erhöhter Mortalität durch Neubildungen.

Laden et al. (2010) finden keinen Zusammenhang zwischen polychlorierten Biphenylen (PCB) und dem Non-Hodgkin Lymphom. Parada et al. (2016) und Li et al. (2005) stellen einen Zusammenhang zwischen PCBs und erhöhtem Brustkrebsrisiko bei Frauen im Alter von 65

Jahren fest. Callahan et al. (2017) zeigen eine Assoziation zwischen PCBs und längeren Telomeren. Hierzu sind Genotypen mit der Vulnerabilität gegenüber den PCBs bei postmenopausalen Frauen identifiziert.

Scinicariello et al. (2016) zeigen, dass Phthalate bei über 60-Jährigen mit längeren Telomeren assoziiert sind und diskutieren diese als Tumorpromotor.

Shin et al. (2010) zeigen eine Assoziation zwischen persistenten organischen Schadstoffen (POPs) und längeren Telomeren bei älteren Menschen (56,2 ± 7,0 Jahre im Durchschnitt) und diskutieren diese als Tumorpromotor in der Karzinogenese. Persistente organische Schadstoffe scheinen mit einem erhöhten Krebsrisiko bei Menschen im Alter zwischen 50 und 65 Jahren assoziiert zu sein (van Larebeke et al., 2015).

Khlifi et al. (2013) stellen steigende Gehalte verschiedener Schwermetalle mit zunehmendem Alter fest. Sie sehen keinen Hinweis, dass Schwermetalle Auslöser von Krebserkrankungen bei über 60-jährigen Menschen sein könnten.

4.2.2 Krankheiten des Blutes und der blutbildenden Organe sowie bestimmte Störungen mit Beteiligung des Immunsystems

Bei Personen im Alter von 70 Jahren scheinen persistente organische Schadstoffe mit Parametern des Komplementsystems assoziiert zu sein und haben einen Einfluss auf das Immunsystem (Kumar et al., 2014).

4.2.3 Endokrine, Ernährungs- und Stoffwechselkrankheiten

Lee et al. (2015) stellen fest, dass Bisphenol A insbesondere bei älteren Frauen über 60 Jahre, jedoch nicht bei Männern, mit Übergewicht assoziiert ist. Ahmadkhaniha et al. (2014) berichten über ein erhöhtes Diabetesrisiko in der älteren Bevölkerung (56,64 ± 9,68 Jahre im Durchschnitt) infolge einer zunehmenden Exposition gegenüber Bisphenol A.

Eriksen et al. (2013) zeigen eine Assoziation zwischen per- und polyfluorierten Chemikalien (POPs) und erhöhten Cholesterolwerten bei älteren Personen zwischen 50 und 65 Jahren.

Die Studien von Li et al. (2017), Knox et al. (2011) und Lewis et al. (2015) deuten auf eine Beeinträchtigung der Schilddrüsenfunktion durch per- und polyfluorierte Chemikalien hin. Erhöhte Konzentrationen an per- und polyfluorierten Chemikalien in der älteren Bevölkerung sind mit Stoffwechselparametern (Cholesterin, Glucose u.a.) und Erkrankungen wie Diabetes, aber nicht mit dem Metabolischen Syndrom assoziiert. Raleigh et al. (2014) finden bei den Älteren keine Assoziation zwischen beruflicher Exposition mit per- und polyfluorierten Chemikalien und erhöhter Mortalität durch Diabetes.

Polychlorierte Biphenyle sind bei Menschen über 70 Jahren mit Übergewicht und bei über 65-Jährigen mit Diabetes assoziiert worden (Lee et al., 2012; Lind et al., 2014). Mit steigenden PCB-Gehalten zeigten Frauen in verschiedenen Altersgruppen (von 18 bis über 75 Jahre) höhere Wahrscheinlichkeiten an Diabetes zu erkranken (Silverstone et al., 2012). Fisher et al. (2013) zeigen in diversen Altersgruppen von 18 bis 74 Jahren, dass die Gehalte an polychlorierten Biphenylen mit dem Alter ansteigen.

In den Studien von Yuan et al. (2018) und Rotter et al. (2015) wurde bei Personen mit einem durchschnittlichen Alter von 60 Jahren kein Zusammenhang zwischen einer Schwermetall-Exposition und dem Risiko, von Diabetes oder dem Metabolischen Syndrom betroffen zu sein, nachgewiesen.

Lind et al. (2012) vermuten bei Frauen, jedoch nicht bei Männern, über 70 Jahren einen Zusammenhang zwischen der Phthalat-Exposition und der Bauchfettverteilung. James-Todd et al. (2016) sehen bei Frauen über 50 Jahren keine Assoziation zwischen einer Phthalat-Exposition und dem Metabolischen Syndrom.

Persistente organische Schadstoffe (POP) sind bei Menschen über 70 Jahren mit der Fettmasse, Diabetes und dem Metabolischen Syndrom assoziiert worden (Ronn et al., 2011; Lind et al., 2017; Lee et al., 2011). Mit steigender POP-Exposition zeigten Turyk et al. (2007) Assoziationen mit Schilddrüsenhormonen, insbesondere bei den über 60-Jährigen. Eine Exposition gegenüber persistenten organischen Schadstoffen scheint ebenfalls mit einem erhöhten Diabetesrisiko bei Menschen im Alter von 50- bis 65 Jahren assoziiert zu sein (van Larebeke et al., 2015).

4.2.4 Psychische und Verhaltensstörungen

Lin et al. (2008) bringen polychlorierte Biphenyle bei Frauen über 60 Jahren mit einer verringerten kognitiven Leistungsfähigkeit in Zusammenhang.

Bei Betroffenen mit Alzheimerkrankheit über 70 Jahre wurden von Baum et al. (2010) geringere Gehalte an Zink im Serum beobachtet. Kognitive Defizite korrelieren bei diesen Personen im Alter mit einer erhöhten Konzentration an Aluminium im Blut.

Kim et al. (2016) beobachten, dass Phthalate bei Personen über 60 Jahren mit Depressionen assoziiert sind.

4.2.5 Krankheiten des Nervensystems

Hatcher-Martin et al. (2012) weisen im Gewebe von über 75-jährigen Betroffenen der Parkinson-Krankheit erhöhte Konzentrationen von polychlorierten Biphenylen nach.

Medehouenou et al. (2014) konnten keine Assoziationen zwischen persistenten organischen Schadstoffen und Krankheiten des Nervensystems bei älteren Menschen über 65 Jahren nachweisen.

4.2.6 Krankheiten des Kreislaufsystems

Bae et al. (2012; 2015) beobachten bei Personen über 60 Jahren und Olsen et al. (2012) und Lind et al. (2011) bei 70-Jährigen eine positive Assoziation von erhöhten Bisphenol A (BPA) Gehalten im Blut mit verschiedenen Risikofaktoren (erhöhter systolischer und diastolischer Blutdruck, Hypertonie, Plaques der Intima Media u.a.). Wang et al. (2015) berichten über eine negative Assoziation von BPA mit Hypertonie und frühen makrovaskulären Erkrankungen bei Personen über 60 Jahren im Vergleich zu Personen unter 60 Jahren.

Lind et al. (2018) stellen fest, dass erhöhte Gehalte an per- und polyfluorierten Chemikalien bei Personen über 70 Jahren positiv mit Risikofaktoren für koronare Herzerkrankungen assoziiert zu sein scheinen. Raleigh et al. (2014) finden bei den Älteren keine Assoziation zwischen beruflicher Exposition mit per- und polyfluorierten Chemikalien und erhöhter Mortalität durch ischämische Herzkrankheit.

Verschiedene Schwermetalle scheinen mit Hypertonie assoziiert zu sein. Insbesondere bei der männlichen, älteren Bevölkerung über 70 Jahre geht eine Exposition gegenüber Arsen mit Hypertonie einher. Eine Erhöhung des Blutdrucks bei der älteren Bevölkerung wird auch als Folge einer Belastung durch diverse Phthalate vermutet (Mordukhovich et al., 2012 und Shiue, 2014).

Erhöhte Phthalat-Gehalte bei Menschen im Alter von 70 Jahren scheinen mit Risikofaktoren (Plaques der Intima Media, Veränderung der Intima-Media-Dicke) für koronare Herzerkrankungen assoziiert zu sein (Wiberg et al., 2014).

Bei den 70-jährigen Personen ist die Exposition gegenüber persistenten organischen Schadstoffen mit Hypertonie und koronaren Risikofaktoren assoziiert und stellt einen Risikofaktor für Herzinsuffizienz dar (Lee et al., 2012; Lind et al., 2012, 2014; Mobacke et al., 2018; Lind et al., 2013). Neben Hypertonie konnten Assoziationen zwischen persistenten organischen Schadstoffen (van Larebeke et al., 2015) mit einem erhöhten Mortalitätsrisiko bei älteren Menschen festgestellt werden (Kim et al., 2017; Kim et al., 2015; Lin et al., 2017; Fry & Power, 2017; Hong et al., 2012).

4.2.7 Krankheiten des Atmungssystems

Park et al. (2013) identifizieren genetische Polymorphismen bei der Interaktion von Phthalat-Exposition und der Lungenfunktion bei Personen über 60 Jahren.

4.2.8 Krankheiten des Verdauungssystems

Kumar et al. (2014) zeigen bei den 70-Jährigen eine Assoziation zwischen persistenten organischen Schadstoffen und Leberfunktionsstörungen auf. Die Konzentration an persistenten organischen Schadstoffen im Urin ist mit der Mundgesundheit sowohl bei Personen zwischen 60 und 80 Jahren als auch bei den jüngeren Generationen assoziiert (Shiue, 2015).

4.2.9 Symptome und abnorme klinische und Laborbefunde, die anderenorts nicht klassifiziert sind

Bei Männern über 60 Jahren scheinen Phthalate einen negativen Einfluss auf das Reproduktionshormon AMH zu haben. Bei den unter 60-Jährigen konnte dieser Effekt hingegen nicht gezeigt werde (Li et al., 2017).

4.2.10 Zusammenfassung

Die für das Themenfeld ***Chemikalien*** identifizierten Studien zeigen

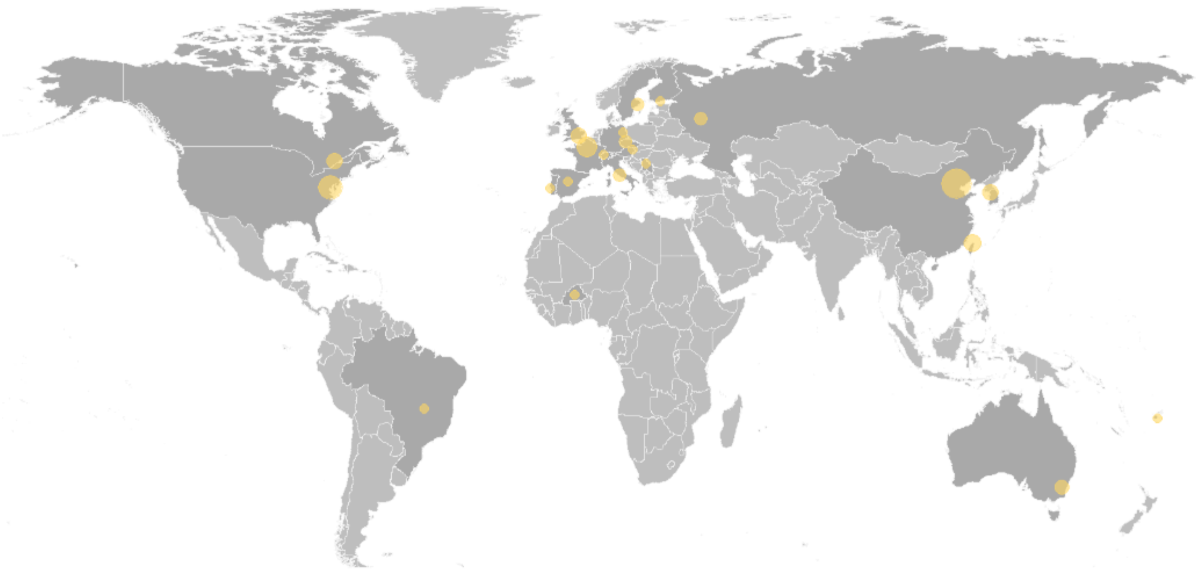
- Assoziationen zwischen der Exposition gegenüber polychlorierten Biphenylen, Phthalaten sowie persistenten organischen Schadstoffen und dem Vorkommen von längeren Telomeren, die als Tumorpromotor diskutiert werden.
- einen Einfluss persistenter organischer Schadstoffe auf das Immunsystem.
- Assoziationen zwischen der Exposition gegenüber Bisphenol A, per- und polyfluorierten Chemikalien, polychlorierten Biphenylen, Schwermetallen, Phthalaten sowie persistenten organischen Schadstoffen und dem Diabetes Risiko.
- Zusammenhänge zwischen der Exposition gegenüber polychlorierten Biphenylen sowie Aluminium und dem Auftreten von kognitiven Defiziten.
- Assoziationen zwischen der Exposition gegenüber Bisphenol A, per- und polyfluorierten Chemikalien, polychlorierten Biphenylen, Schwermetallen, Phthalaten sowie persistenten organischen Schadstoffen und dem Auftreten von Herz-Kreislauf-Erkrankungen.

- Assoziationen zwischen der Exposition gegenüber persistenten organischen Schadstoffen und Leberfunktionsstörungen sowie der Mundgesundheit.

4.3 Vulnerabilität gegenüber Umwelteinflüssen durch den Klimawandel

Insgesamt wurden 95 Studien (bzw. Publikationen) identifiziert, die sich mit der Vulnerabilität älterer Menschen gegenüber Umwelteinflüssen durch den Klimawandel beschäftigen, davon 39 % in Asien, 30 % in Europa und 21 % in Amerika. Allein 28 % der Studien fanden in China statt (Abbildung 9, Tabelle 12).

Abbildung 9: Orte der Durchführung der Studien zu Umwelteinflüssen durch den Klimawandel



Die Größe der Kreise ist proportional zur Anzahl der Studien. Der Mittelpunkt der Kreise liegt jeweils auf den Koordinaten der Landeshauptstadt.
Quelle: eigene Darstellung BioMath GmbH

Tabelle 12: Orte der Durchführung der Studien zu Umwelteinflüssen durch den Klimawandel

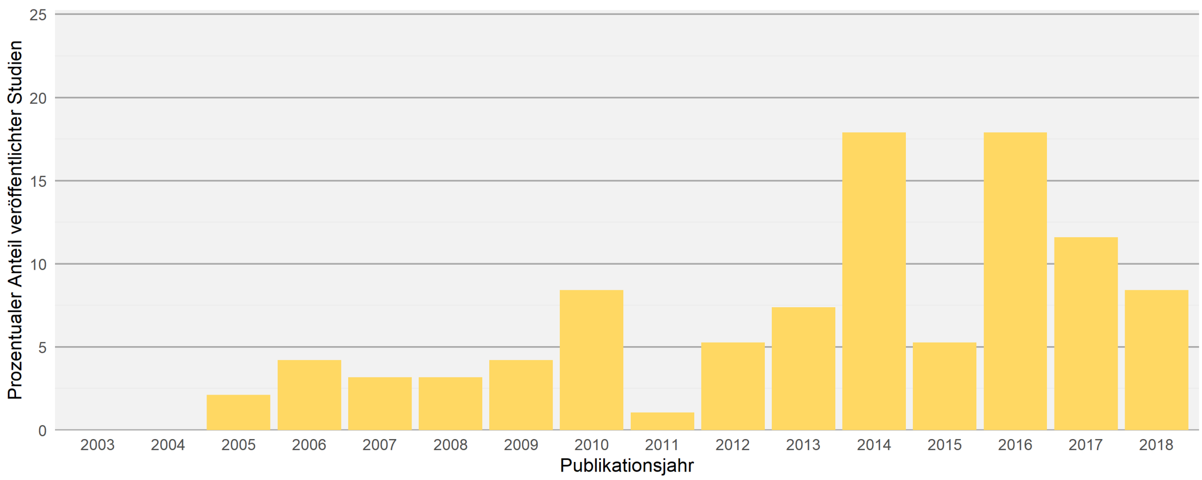
Region (Land)	Anzahl
Afrika (Burkina Faso: 1)	1
Amerika (Brasilien: 1, Kanada: 4, USA: 15)	20
Asien (China: 25, Ostasien:1, Taiwan: 5, Tibet: 2, Korea: 4)	37
Europa (Deutschland: 1, Europa: 1, Finnland: 1, Frankreich: 9, Italien: 2, Österreich: 1, Portugal: 1, Russland: 2, Schweden: 6, Schweiz: 1, Serbien: 1, Spanien: 1, Tschechien: 2, Vereinigtes Königreich: 1)	29
Ozeanien (Australien: 3, Fidschi: 1)	4
k. A.	4
Total	**95**

Die Veröffentlichung der Studien war gemäß Suchprotokoll zwischen 2003 und 2018 mit zwei überdurchschnittlichen Jahren 2014 und 2019 (Tabelle 13, Abbildung 10).

Tabelle 13: Jahr der Veröffentlichung der Studien zu Umwelteinflüssen durch den Klimawandel

Jahr	Anzahl	Jahr	Anzahl	Jahr	Anzahl	Jahr	Anzahl
2003	0	2007	3	2011	1	2015	5
2004	0	2008	3	2012	5	2016	17
2005	2	2009	4	2013	7	2017	11
2006	4	2010	8	2014	17	2018	8

Abbildung 10: Jahr der Veröffentlichung der Studien zu Umwelteinflüssen durch den Klimawandel



Quelle: eigene Darstellung BioMath GmbH

In den 95 Studien wurden die Auswirkungen von Hitzebelastungen, Hochwasser/Überflutung und Sturm/Starkregen auf die Gesundheitsinfrastruktur, die Morbidität und die Mortalität betrachtet (Tabelle 14).

Tabelle 14: Anzahl identifizierter Studien zu Vulnerabilität (Outcome) bei Belastungen durch den Klimawandel (Exposition)

	Exposition			
Outcome	**Hitzebelastungen**	**Hochwasser/Überflutung**	**Sturm/Starkregen**	**Gesamtergebnis**
Gesundheitsinfrastruktur	**22**		**1**	**23**
F00-F99 Psychische und Verhaltensstörungen	1			1

Outcome	Exposition: Hitzebelastungen	Hochwasser/Überflutung	Sturm/Starkregen	Gesamtergebnis
I00-I99 Krankheiten des Kreislaufsystems	7			7
J00-J99 Krankheiten des Atmungssystem	1			1
N00-N99 Krankheiten des Urogenitalsystems	1			1
E87 Sonstige Störungen des Wasser- und Elektrolythaushaltes sowie des Säure-Basen-Gleichgewichts			1	1
Diverse*	12			12
Morbidität	**12**	**2**	**3**	**17**
A00-B99 Bestimmte infektiöse und parasitäre Krankheiten		1		1
F00-F99 Psychische und Verhaltensstörungen		1	1	2
I00-I99 Krankheiten des Kreislaufsystems	6			6
J00-J99 Krankheiten des Atmungssystems	3		1	4
S00-T98 Verletzungen, Vergiftungen und bestimmte andere Folgen äußerer Ursachen	3		1	4
Mortalität	**54**		**1**	**55**
I00-I99 Krankheiten des Kreislaufsystems	8			8
S00-T98 Verletzungen, Vergiftungen und bestimmte andere Folgen äußerer Ursachen			1	1
Diverse*	46			46
Gesamtergebnis	**88**	**2**	**5**	**95**

* Studien, die mindestens zwei Themenschwerpunkte/Outcomes enthalten (Bsp.: C00-D48 Neubildungen; E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten; I00-I99 Krankheiten des Kreislaufsystems)

Von den 95 Studien zu den gesundheitlichen Auswirkungen des Klimawandels stellten 68 (72 %) eine erhöhte Vulnerabilität exponierter älterer Menschen im Vergleich zu nicht exponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen fest, 21 Studien (22 %) fanden keine Unterschiede, 3 Studien (3 %) stellten eine geringere Vulnerabilität im Vergleich zu anderen Altersklassen und 3 Studien (3 %) sowohl erhöhte als auch geringere Vulnerabilität fest (Tabelle 15).

Tabelle 15: Ergebnisse der Studien zu Umwelteinflüssen durch den Klimawandel

Effekt	Code	Anzahl
Exponierte ältere Menschen sind vulnerabler im Vergleich zu nichtexponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen	+	68
Sowohl höhere als auch geringere Vulnerabilität	+/-	3
Keine Unterschiede zwischen den untersuchten Gruppen	0	21
Exponierte ältere Menschen sind weniger vulnerabel im Vergleich zu nichtexponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen	-	3

Keine Studie konnte mit dem höchsten Summenqualitätsscore ++++ bewertet werden. Sechs Studien wurden mit +++ bewertet. 66 Studien erhielten den Gesamtscore ++, hier wurden in der Regel Registerdaten aus Todesregistern mit Wetterdaten verknüpft. 26 Studien erhielten den Gesamtscore + (Tabelle 16). Die kontrollierte Exposition ist das Qualitätskriterium, das von den wenigsten Studien erfüllt wird.

Tabelle 16: Qualität der Studien zu Umwelteinflüssen durch den Klimawandel

	Qualitätskriterium				
Kombinationsscore	**Studientyp**	**kontrollierte Exposition**	**Einzeldaten**	**Vergleichsgruppe**	**Anzahl Studien**
++++	+	+	+	+	**4**
+++	-	+	+	+	**2**
+++	+	-	+	+	**61**
++	-	-	+	+	**5**
++	+	-	+	-	**8**
+	-	-	+	-	**18**
Anzahl Studien, die das Qualitätskriterium erfüllen (+)	**11**	**4**	**90**	**68**	**95**

Im Folgenden wird eine Zusammenfassung der Ergebnisse gegeben. Einzelheiten zu jeder Studie inklusive Ergebnis- und Qualitätsbewertung finden sich im Anhang B.2.

4.3.1 Bestimmte infektiöse und parasitäre Krankheiten

Menschen, die in Armut leben und Personen ab 60 Jahren scheinen vulnerabler für das Auftreten der Erkrankung Leptospiriose nach Flutkatastrophen, konstatieren Lau et al. (2016).

4.3.2 Psychische und Verhaltensstörungen

Chan et al. (2018) zeigen einen Anstieg der Krankenhauseinweisungen bei Älteren mit psychischen Erkrankungen, insbesondere bei den über 75-Jährigen mit dem Anstieg der Umgebungstemperatur. Liu et al. (2006) beobachten bei älteren Menschen über 60 Jahren und besonders Frauen, die Opfer von Überflutungen wurden, posttraumale Belastungsstörungen. Sirey et al. (2017) konstatieren, dass in von Stürmen betroffenen Gebieten bei Personen im Alter ab 60 Jahren häufiger depressive Symptome auftreten als in der Allgemeinbevölkerung.

4.3.3 Krankheiten des Kreislaufsystems

Zheng et al. (2016) und Wang et al. (2013) stellen eine bei hohen Tagestemperatur-Schwankungen erhöhte Anzahl an Notfallaufnahmen von Älteren über 65 Jahren mit Herz-Kreislauferkrankungen fest, wobei über 75-jährige vulnerabler als über 65-Jährige sind.

Lam et al. (2018) beobachten bei DiabetespatientInnen ein höheres Risiko für Krankenhauseinweisungen aufgrund von Herzinfarkt, jedoch keine altersbedingten Unterschiede. Auch Wang et al. (2018) sehen, dass Notfallaufnahmebesuche häufiger sind bei allen Betroffenen mit präklinischem Herzstillstand, aber ebenfalls keine Altersgruppenunterschiede erkennbar sind. Der Einfluss der Hitzeeffekte auf die Anzahl der Krankenhauseinweisungen aufgrund von Herz- und Kreislauferkrankungen ist höher für Jüngere (0–14 und 15–64) als für Ältere (65–74 und über 75 Jahre), beobachten Son et al. (2014). Extreme Hitze erhöht die Anzahl von Krankenhauseinweisungen bei älteren Menschen über 65 Jahren aufgrund von Nieren- und Atemwegsbeschwerden sowie Hitzebeschwerden. Stärkere Effekte konnten bei sehr Alten, Schwarzen, Personen mit geringer Bildung und fehlender Klimaanlage beobachtet werden (Gronlund et al., 2016).

Keinen Zusammenhang zwischen hohen Temperaturen und Krankenhauseinweisungen aufgrund von Herzinfarkt (bei Männern und über 65 Jahren) sehen Liu et al. (2018) und Bayentin et al. (2010). Keine alters- oder geschlechtsspezifischen Unterschiede in Bezug auf die Anzahl an Notrufen aufgrund von Vorhofflattern finden Brunetti et al. (2014). da Silva et al. (2012) sehen ebenfalls keinen Zusammenhang zwischen Krankenhauseinweisungen aufgrund von Herz- und Kreislauferkrankungen und verschiedenen Wettervariablen. Eine Ausnahme bilden über 60-Jährigen mit einem niedrigen sozioökonomischen Status.

Eine erhöhte jahreszeitliche Durchschnittstemperatur ist verbunden mit einem Rückgang der Krankenhauseinweisungen aufgrund von Schlaganfall in den Altersgruppen 18 bis 64 und über 65 Jahre (Lichtman et al., 2016). Nach zweitägiger Hitze-Exposition stellen Ha et al. (2014) bei über 65-Jährigen ein erhöhtes Risiko der Krankenhauseinweisungen aufgrund von Schlaganfällen fest, wobei die über 80-Jährigen besonders betroffen scheinen.

Son et al. (2014) weisen Effekte einer Hitzewelle für die Anzahl der Krankenhauseinweisungen aufgrund von Herz- und Kreislauferkrankungen nach, die höher für Jüngere (0 bis 14 und 15 bis 64 Jahre) als für Ältere (65 bis 74 und ≥75 Jahre) sind.

Hitzetage sind verbunden mit einer erhöhten Anzahl an Notrufen (DeVine et al., 2017; Fuhrmann et al., 2016; Xiao et al., 2017; Knowlton et al., 2009; Chan et al., 2011; Bai et al., 2014; Zhang et al., 2014). Es werden hierzu gegensätzliche Aussagen zu den Altersunterschieden gemacht: Das Alter scheint keinen Einfluss zu haben. Besonders vulnerabel scheinen Schulkinder und über 75-Jährige, Kinder (unter 14 Jahre) und Ältere (über 65 Jahre) zu sein, insbesondere mit einem niedrigen Sozialstatus. Andere Beobachtungen sehen die Kleinkinder (0 bis 4 Jahre) und Ältere (über 65 Jahre) am meisten gefährdet. Notrufe von Älteren über 75 Jahren sind doppelt so häufig wie von Älteren und Hilfsbedürftigen unter 75 Jahren, andererseits ist der Einfluss hoher Temperaturen auf die Zahl der Notrufe relativ konstant über alle Altersgruppen.

Kang et al. (2016) schlussfolgern, dass sowohl unter 65-Jährige als auch über 65-Jährige bei Hitzewellen ein erhöhtes relatives Risiko eines präklinischen Herzstillstandes haben. Bei den

Personen über 65 Jahren fällt dies höher aus und ist signifikant. Keine signifikanten Effekte von Hitzewellen auf die Anzahl der Herzinfarkte in den Altersgruppen 65 bis 74 und über 75 Jahre sehen Smith et al. (2016). Die Symptomhäufigkeit ist erhöht bei älteren Menschen mit kardiovaskulären Erkrankungen im Vergleich zu älteren Menschen ohne kardiovaskuläre Erkrankungen (Fink et al., 2017). Alperovitch et al. (2009) sehen einen Zusammenhang zwischen einem erhöhten Blutdruck und der erhöhten Außentemperatur bei Älteren, insbesondere bei den über 80-Jährigen.

Ein erhöhtes Herzinfarktrisiko bei Temperaturrückgang in allen Altersklassen, besonders bei den 75 bis 84-Jährigen, sehen Bhaskaran et al. (2010).

Eine erhöhte kardiovaskuläre Mortalität bei älteren Menschen während einer Hitzewelle und hohen Tagestemperaturschwankungen stellen Dong et al. (2016); Tam et al. (2009); Yang et al. (2015); Davidkovova et al. (2014); Kynast-Wolf et al. (2010); Huang et al. (2017, 2014); Yang et al. (2018); Johnson et al. (2016), Sung et al. (2013) und andere fest. Auch Harlan et al. (2014) sehen diesen Anstieg, aber keine Unterschiede nach Alter oder Geschlecht. Johnson et al. (2016) sehen unverheiratete Männer als besonders vulnerabel, Dong et al. (2016), Yang et al. (2018), D'Ippoliti et al. (2010), Rey et al. (2007) und Monteiro et al. (2013) hingegen sehen Frauen mehr gefährdet als Männer.

Hitze erhöht die Mortalität sowie potenziell verlorene Lebensjahre durch Herz- und Kreislauf- sowie Atemwegserkrankungen, insbesondere bei den über 75-Jährigen (Yang et al., 2015; Zhou et al., 2014; Vicedo-Cabrera et al., 2016; Li et al., 2017; Monteiro et al., 2013 u.a.).

Einen Zusammenhang zwischen der Mortalität und den Lebensbedingungen (Hausausstattung, Armut, Flächenversiegelung, Bluthochdruck) stellten Klein Rosenthal et al. (2014) fest.

Es konnte kein Zusammenhang zwischen der Außentemperatur und der Mortalität bei über 65-Jährigen von Xu et al. (2013) oder bei unter 75-Jährigen von Schaeffer et al. (2016) festgestellt werden.

4.3.4 Krankheiten des Atmungssystems

Einen Anstieg der Asthma-bedingten Notaufnahmebesuche bei Anstieg der Temperaturen stellen Kim et al. (2014) fest, wobei die höchste Zahl der Notaufnahmebesuche bei den über 65-Jährigen im Herbst liegt. Wang et al. (2013) finden bei hohen Tagestemperaturschwankungen eine erhöhte Anzahl an Notfallaufnahmen von Älteren über 65 Jahren mit Atemwegs- und Verdauungserkrankungen, wobei über 75-Jährige vulnerabler als über 65-Jährige sind. Bei Temperaturen von 30°C wird von Wang, Yu-Chun et al. (2015) eine erhöhte Zahl von ambulanten Arztbesuchen bei älteren Menschen über 65 Jahren beobachtet. Es besteht jedoch kein Unterschied zu jüngeren Personen unter 65 Jahren.

Ein Anstieg der Innentemperatur über 26°C ist bei älteren Menschen über 65 Jahren verbunden mit der Verschlechterung von COPD Symptomen und der vermehrten Verwendung von Inhalatoren (McCormack et al., 2016).

Keinen Effekt der Temperaturschwankungen im Sommer auf die Häufigkeit der Atemwegserkrankungen bei Älteren findet Sun et al. (2018).

Der Effekt von Temperaturerhöhungen jenseits der 36°C auf die Anzahl von Krankenhauseinweisungen ist sehr gering. Am vulnerabelsten sind die über 75-Jährigen mit Atemwegserkrankungen (Linares et al., 2008).

Tu & Chen (2017) beobachten nach dem Taifun Morakot, dass Kinder die am stärksten gefährdete Bevölkerungsgruppe im Vergleich zu Erwachsenen und Personen über 65 Jahren für das Auftreten einer Pneumonie sind.

4.3.5 Krankheiten des Urogenitalsystems

Lin et al. (2013) sehen keinen Unterschied in der Anzahl temperaturbedingter Krankenhauseinweisungen zwischen Jüngeren unter 65 und Älteren über 65 Jahren aufgrund von Nierenerkrankungen.

4.3.6 Verletzungen, Vergiftungen und bestimmte andere Folgen äußerer Ursachen

Der Selbst-Bericht negativer Auswirkungen von Hitze auf die Gesundheit variiert mit medizinischer Vorgeschichte, Geschlecht, Einkommen etc. (Belanger et al., 2014).

Das Risiko eines Hitzeschlages ist an den Tagen 0-6 nach einer Hitzewelle bei älteren Menschen über 65 Jahren erhöht (Li et al., 2017). Hitzebedingter erhöhter Puls, erhöhte Körpertemperatur und Atemnot bei Älteren über 70 Jahren ist verstärkt bei Krankheiten wie Bluthochdruck und kognitiven Störungen zu beobachten (Oberlin et al., 2010).

Bei Menschen über 65 Jahren, die Opfer des Hurrikans Katrina wurden und über einen längeren Zeitraum von ihren Wohnstätten vertrieben wurden, ist die Wahrscheinlichkeit größer, von Frakturen, insbesondere von Hüftfrakturen betroffen zu sein als bei nicht Vertriebenen (Uscher-Pines et al., 2009). Seil et al. (2016) beobachten nach Hurrikan Sandy, dass über 65-jährige, insbesondere männliche Personen die meisten Todesfälle aufgrund von Verletzungen (z. B Ertrinken, Stürze) zählten.

4.3.7 Sonstige Störungen des Wasser- und Elektrolythaushaltes sowie des Säure-Basen-Gleichgewichts

Swerdel et al. (2016) beobachten nach dem Hurrikan Sandy eine deutliche Zunahme von Krankenhausaufenthalten wegen Dehydration bei Personen im Alter von über 65 Jahren im Vergleich zu den vorangegangenen 4 Jahren und zu Personen unter 65 Jahren.

4.3.8 Zusammenfassung

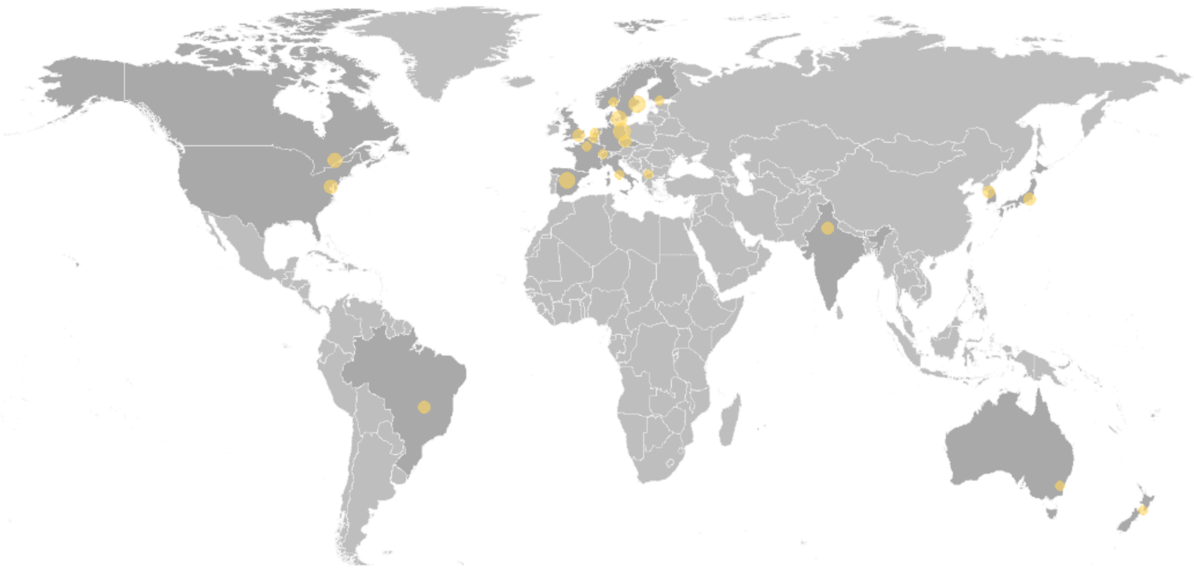
Die für das Themenfeld ***Klimawandel*** identifizierten Studien zeigen

- einen Anstieg der Krankenhauseinweisungen, Notfallaufnahmebesuche und Notrufe an Hitzetagen, insbesondere bei Menschen über 75 Jahre und aufgrund von Erkrankungen des Herz-Kreislauf-Systems oder der Atemwege,
- eine erhöhte Mortalität während Hitzewellen und hohen Tagestemperaturschwankungen, insbesondere bei Menschen über 75 Jahren,
- Zusammenhänge zwischen hitzebedingter Mortalität sowie gesundheitlichen Notfällen und den Lebensbedingungen, aber keine eindeutigen Unterschiede nach Geschlecht,
- einen Zusammenhang zwischen dem Auftreten von Überflutungen und Stürmen und der Entstehung von psychischen Erkrankungen bei Menschen über 60 Jahren.

4.4 Vulnerabilität gegenüber Umwelteinflüssen durch Lärm

Insgesamt wurden 53 Studien (bzw. Publikationen) identifiziert, die sich mit der Vulnerabilität älterer Menschen gegenüber Umwelteinflüssen durch Lärm beschäftigen, davon allein 36 (68 %) in Europa (Abbildung 11, Tabelle 17).

Abbildung 11: Orte der Durchführung der Studien zu Umwelteinflüssen durch Lärm



Die Größe der Kreise ist proportional zur Anzahl der Studien. Der Mittelpunkt der Kreise liegt jeweils auf den Koordinaten der Landeshauptstadt.
Quelle: eigene Darstellung BioMath GmbH

Tabelle 17: Orte der Durchführung der Studien zu Umwelteinflüssen durch Lärm

Region (Land)	Anzahl
Afrika	0
Amerika (Brasilien: 2, Kanada: 4, USA: 3)	9
Asien (Indien: 2, Japan: 2, Korea: 2)	6
Europa (Belgien: 1, Dänemark: 5, Deutschland: 7, Gesamteuropa: 1, Finnland: 1, Frankreich: 1, Italien: 1, Mazedonien: 1, Niederlande: 1, Norwegen: 1, Schweden: 6, Schweiz: 1, Spanien: 5, Tschechien: 2, Vereinigtes Königreich: 2)	36
Ozeanien (Australien: 1, Neuseeland: 1)	2
Total	**53**

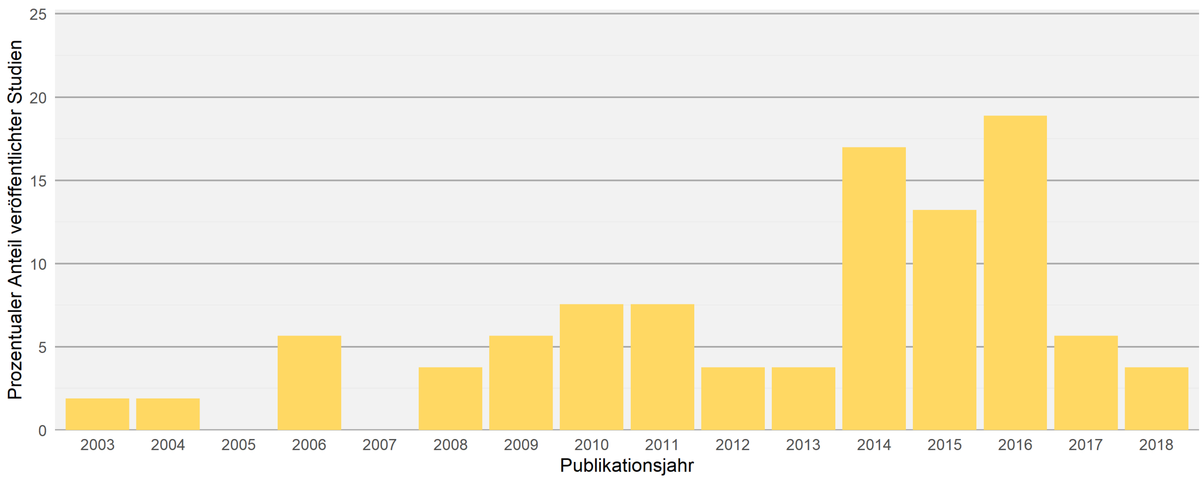
Die Veröffentlichung der Studien war gemäß Suchprotokoll zwischen 2003 und 2018 mit einer Zunahme der Anzahl von Studien in den Jahren 2014 bis 2016 (Abbildung 12, Tabelle 18).

Tabelle 18: Jahr der Veröffentlichung der Studien zu Umwelteinflüssen durch Lärm

Jahr	Anzahl		Jahr	Anzahl		Jahr	Anzahl		Jahr	Anzahl
2003	1		2007	0		2011	4		2015	7

Jahr	Anzahl		Jahr	Anzahl		Jahr	Anzahl		Jahr	Anzahl
2004	1		2008	2		2012	2		2016	10
2005	0		2009	3		2013	2		2017	3
2006	3		2010	4		2014	9		2018	2

Abbildung 12: Jahr der Veröffentlichung der Studien zu Umwelteinflüssen durch Lärm



Quelle: eigene Darstellung BioMath GmbH

In den 53 identifizierten Studien wurden die Auswirkungen von Alltags-, Industrie- und Verkehrslärm auf Morbidität und Mortalität betrachtet (Tabelle 19).

Tabelle 19: Anzahl identifizierter Studien zur Vulnerabilität (Outcome) bei Lärm (Exposition)

	Exposition			
Outcome	**Alltagslärm**	**Industrielärm**	**Verkehrslärm**	**Gesamtergebnis**
Morbidität	**4**	**9**	**34**	**47**
F00-F99 Psychische und Verhaltensstörungen	2		16	18
H60-H95 Krankheiten des Ohres und des Warzenfortsatzes	2	6		8
I00-I99 Krankheiten des Kreislaufsystems		3	15	18
Diverse*			3	3
Mortalität			**6**	**6**
C00-D48 Neubildungen			1	1
I00-I99 Krankheiten des Kreislaufsystems			1	1

	Exposition			
J00-J99 Krankheiten des Atmungssystems			1	1
Diverse*			3	3
Gesamtergebnis	**4**	**9**	**40**	**53**

* Studien, die mindestens zwei Themenschwerpunkte/Outcomes enthalten (Bsp.: C00-D48 Neubildungen; E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten; I00-I99 Krankheiten des Kreislaufsystems)

Von den 53 Studien stellten 29 (55 %) eine erhöhte Vulnerabilität exponierter älterer Menschen im Vergleich zu nichtexponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen gegenüber Lärm fest. 20 Studien (38 %) fanden keine Unterschiede und vier Studien (7 %) stellten eine geringere Vulnerabilität im Vergleich zu anderen Altersklassen fest (Tabelle 20).

Tabelle 20: Ergebnisse der Studien zu Umwelteinflüssen durch Lärm

Effekt	Code	Anzahl
Exponierte ältere Menschen sind vulnerabler im Vergleich zu nicht exponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen	+	29
Keine Unterschiede zwischen den untersuchten Gruppen	0	20
Exponierte ältere Menschen sind weniger vulnerabel im Vergleich zu nichtexponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen	-	4

Drei Studien konnten mit dem höchsten Summenqualitätsscore ++++ bewertet werden. 20 Studien wurden mit +++ bewertet, wobei bei 18 Studien die Exposition nicht kontrolliert wurde und bei zwei Studien keine Vergleichsgruppe vorhanden war. 18 Studien erhielten den Gesamtscore ++, acht Studien den Gesamtscore +. Vier Studien erfüllten keines der vier Qualitätskriterien (Tabelle 21). Eine kontrollierte Exposition ist das Qualitätskriterium, das von den wenigsten Studien erfüllt wird.

Tabelle 21: Qualität der Studien zu Umwelteinflüssen durch Lärm

	Qualitätskriterium				
Kombinationsscore	**Studientyp**	**kontrollierte Exposition**	**Einzeldaten**	**Vergleichsgruppe**	**Anzahl Studien**
++++	+	+	+	+	**3**
+++	+	-	+	+	**18**
+++	+	+	+	-	**2**
++	-	-	+	+	**2**
++	+	-	+	-	**16**
+	-	-	+	-	**8**
	-	-	-	-	**4**

	Qualitätskriterium				
Anzahl Studien, die das Qualitätskriterium erfüllen (+)	**39**	**5**	**49**	**23**	**53**

Im Folgenden wird eine Zusammenfassung der Ergebnisse gegeben. Einzelheiten zu jeder Studie inklusive Ergebnis- und Qualitätsbewertung finden sich im Anhang B.3.

4.4.1 Psychische und Verhaltensstörungen

Dratva et al. (2010) stellen fest, dass die empfundene Lärmbelästigung mit steigendem Alter zurückgeht. Anwohnende über 65 Jahren sind nicht beeinträchtigt von einer erhöhten Verkehrslärmbelastung modellieren Carrier et al. (2016).

Van den Berg et al. (2014), Ristovska et al. (2009) und Schreckenberg et al. (2010) beschreiben, dass die gefühlte Belästigung durch Lärm und Schlafstörungen aufgrund von Lärm den stärksten Zusammenhang im Alter von etwa 40 bis 60 Jahren zeigen und mit steigendem Alter eher abnehmen. Oiamo et al. (2015) und Guite et al. (2006) stellen eine bessere mentale Gesundheit im Alter über 65 Jahre fest.

Carugno et al. (2018) finden einen Zusammenhang zwischen selbstberichteter Lärmbelastung und lärmbedingten Schlafstörungen bei Personen zwischen 45 und 70 Jahren. van Renterghem et al. (2012) und Méline et al. (2013) finden keinen Einfluss des Alters auf das Lärmempfinden. Schreckenberg et al. (2010) konnten keinen Zusammenhang zwischen der Lärmbelästigung und Auswirkungen auf die subjektive physische und mentale Gesundheit aufzeigen. Bluhm et al. (2004) finden keine altersbedingten Unterschiede bei selbstberichteten Schlafstörungen durch Verkehrslärm. Sygna et al. (2014) konnten durch Befragungen der Teilnehmenden die Schlafqualität bei Verkehrslärm bei über 66-Jährigen als mittel bis gut und bei 51 bis 65-Jährigen als schlecht bewerten. Vandasova et al. (2016) sehen keinen Einfluss des Alters auf die wahrgenommene Lärmbelästigung und damit zusammenhängenden Schlafstörungen.

Linares et al. (2017) schlussfolgern, dass Lärm Demenz-Symptome bis hin zur Notwendigkeit einer Krankenhauseinweisung verstärken kann. Das Alter hat keinen Einfluss auf den Zusammenhang zwischen Lärmsensibilität und Depression, stellen Hill et al. (2014) fest.

Nach Okokon et al. (2015) erhöht das Wissen um Gesundheitsrisiken die Lärmsensibilität. Zudem habe das Bildungsniveau einen Einfluss auf lärmbedingte Depressionen, wobei Menschen mit einer Ausbildungszeit von weniger als 13 Jahren mehr betroffen scheinen (Orban et al., 2016).

Öhrström et al. (2006) zeigen einen deutlichen gesundheitlichen Nutzen von lärmabgeschirmten Wohnbereichen (Zugang zu einer ruhigen Seite der eigenen Wohnung, z. B. Schlafzimmer nicht zur Straße gelegen) auf.

4.4.2 Krankheiten des Ohres und des Warzenfortsatzes

Rosenhall (2003) stellt fest, dass Tinnitus-Erkrankungen im Alter bei vorheriger beruflicher Lärmbelastung doppelt so oft auftreten. Keinen Unterscheid in der Prävalenz von Tinnitus im Alter mit und ohne vorherige berufliche Lärmbelästigung finden Melo et al. (2012). Al-Swiahb et al. (2016) beschreiben einen subjektiv lauteren und belastenderen Tinnitus bei älteren über 60-Jährigen im Vergleich zu jüngeren PatientInnen. Hederstierna et al. (2016) und Kovalova et al. (2016) konstatieren keinen häufigeren Hörverlust nach vorheriger beruflicher Lärmbelastung bei 70- bis 75-Jährigen im Vergleich zur Gruppe ohne berufliche Lärmbelastung. Die Wahrscheinlichkeit, von einem Hörverlust betroffen zu sein, steigt mit dem Alter und ist bei Männern höher als bei Frauen, resümieren Morata et al. (2011). Die Wahrscheinlichkeit eines Sturzes ist bei Älteren mit Hörverlust über 65 Jahre höher als bei jüngeren Menschen mit Hörverlust (Girard et al., 2014).

4.4.3 Krankheiten des Kreislaufsystems

Yoshioka al. (2019) konstatieren ein steigendes Atherosklerose-Risiko mit zunehmendem Alter, sowie einen Einfluss von beruflicher selbstbewerteter Lärmbelastung auf dieses Risiko. Girard (2014) stellt einen Effekt von beruflicher Lärmbelastung (gemessen) auf die kardiovaskuläre Mortalität, auch assoziiert mit Hörverlust fest. Hypertonie und Medikamente gegen hohen Blutdruck sind hoch prävalent in der Gruppe der Älteren, finden Fuks et al. (2011). Banerjee et al. (2014) zeigen, dass Hypertonie infolge von Lärmbelastungen in allen Altersgruppen signifikant erhöht ist. Poulsen et al. (2018) stellen mit steigendendem Lärmpegel durch Windturbinen in der Altersgruppe unter 65 Jahre erhöhte Verschreibungen von Medikamenten gegen Bluthochdruck fest. In der Altersgruppe, der über 65-jährigen sind dagegen keine erhöhten Anzahlen an Verschreibungen zu verzeichnen. Schmidt et al. (2015) beobachten eine verminderte Schlafqualität und erhöhten Blutdruck infolge nächtlichen Fluglärms. Bodin et al. (2009) sehen keine klare Assoziation zwischen Verkehrslärm und Hypertonie bei 60 bis 80-Jährigen. Eine starke Assoziation zwischen Verkehrslärmbelästigung und Herzinfarkt bei Älteren über 64,5 Jahren finden Sørensen et al. (2011) und Azuma et al. (2017). Keine Verbindung zwischen Verkehrslärmbelästigung und dem Risiko kardiovaskulärer Erkrankungen sehen Niemann et al. (2006). Keinen Zusammenhang für eine höhere Vulnerabilität bei Älteren über 60 Jahren aufgrund von Lärmbelästigung und lärmbedingten Schlafstörungen sieht van Kamp et al. (2009). Eine höhere Lärmbelastung ist assoziiert mit einem höheren Infarktrisiko. Jedoch besteht kein spezifisches Risiko für Ältere (Sørensen et al., 2014 und Bodin et al., 2016). Halonen et al. (2015) konstatieren ein erhöhtes Infarktrisiko durch Lärm, das nachts höher ist als am Tag. Rhee et al. (2008) und Jarup et al. (2008) stellen keine erhöhte Prävalenz von Hypertonie unter Lärmbelästigung bei älteren im Vergleich zu jüngeren Altersgruppen fest.

Frauen über 60 Jahren, die bis 50 m von einer Schnellstraße entfernt leben, haben ein erhöhtes Risiko für einen plötzlichen Herztod (Hart et al., 2014). Verkehrslärm führt zu einem erhöhten Mortalitätsrisiko durch kardiovaskuläre Erkrankungen, jedoch nicht spezifisch nur bei Älteren, konstatieren Barceló et al. (2016), Recio et al. (2016) und Tobias et al. (2015).

Andrew et al. (2013) zeigen auf, dass Krankenhauseinweisungen aufgrund von kardiovaskulären Erkrankungen im Zusammenhang mit höherer Lärmbelastung steigen.

4.4.4 Krankheiten des Atmungssystems

Bei Älteren über 65 Jahren besteht ein erhöhtes Mortalitätsrisiko durch Erkrankungen der Atemwege im Zusammenhang mit steigender Lärmbelastung, berichten Tobías et al. (2014).

4.4.5 Neubildungen

Keinen Zusammenhang zwischen Lärm und der Mortalität bei Brustkrebs stellen Roswall et al. (2016) fest.

4.4.6 Zusammenfassung

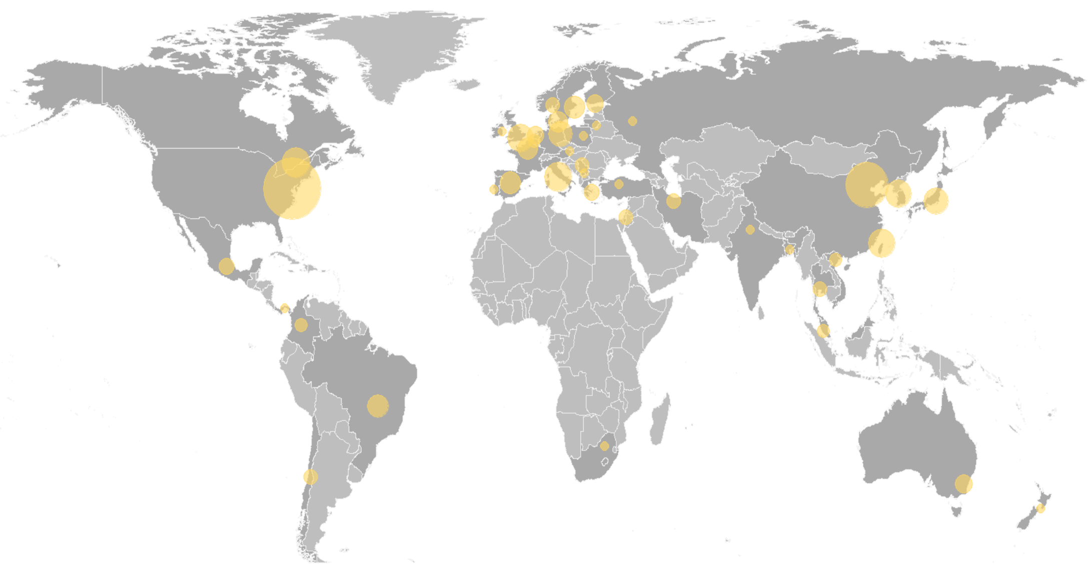
Die für das Themenfeld ***Lärm*** identifizierten Studien zeigen

- einen Zusammenhang zwischen Lärmbelästigung und Schlafstörungen. Ein Einfluss des Alters und eine besondere Vulnerabilität älterer Menschen werden nicht nachgewiesen, eher lässt im Alter bei über 65-Jährigen die Lärmsensibilität nach,
- eine höhere Wahrscheinlichkeit im Alter von einem Hörverlust und Tinnitus betroffen zu sein, jedoch ohne Zusammenhang zu einer vorherigen beruflichen Lärmbelästigung,
- einen Zusammenhang zwischen Lärmbelästigung und Herz-Kreislauf-Krankheiten. Das Risiko kardiovaskulärer Erkrankungen infolge einer Lärmexposition ist bei älteren Menschen höher als bei jüngeren Menschen, jedoch wird eine besondere Vulnerabilität älterer Menschen gegenüber Lärm nicht nachgewiesen.

4.5 Vulnerabilität gegenüber Umwelteinflüssen durch Luftbelastungen

Insgesamt wurden 466 Studien (bzw. Publikationen) identifiziert, die sich mit der Vulnerabilität älterer Menschen gegenüber Umwelteinflüssen durch Luftbelastungen beschäftigen, etwa gleich viele in Amerika, Asien und Europa. Die meisten Studien wurden in den USA durchgeführt (138), gefolgt von China (69) (Abbildung 13, Tabelle 22).

Abbildung 13: Orte der Durchführung der Studien zu Umwelteinflüssen durch Luftbelastungen



Die Größe der Kreise ist proportional zur Anzahl der Studien. Der Mittelpunkt der Kreise liegt jeweils auf den Koordinaten der Landeshauptstadt.
Quelle: eigene Darstellung BioMath GmbH

Tabelle 22: Orte der Durchführung der Studien zu Umwelteinflüssen durch Luftbelastungen

Region (Land)	Anzahl
Afrika (Südafrika: 1)	1
Amerika (Brasilien: 11, Chile: 3, Kanada: 24, Kolumbien: 2, Lateinamerika: 1, Mexiko: 4, Panama: 1, USA: 138)	184
Asien (Bangladesch: 1, China: 69, Indien: 1, Iran: 3, Israel: 3, Japan: 17, Korea: 19, Malaysia: 2, Taiwan: 21, Thailand: 3, Vietnam: 2)	141

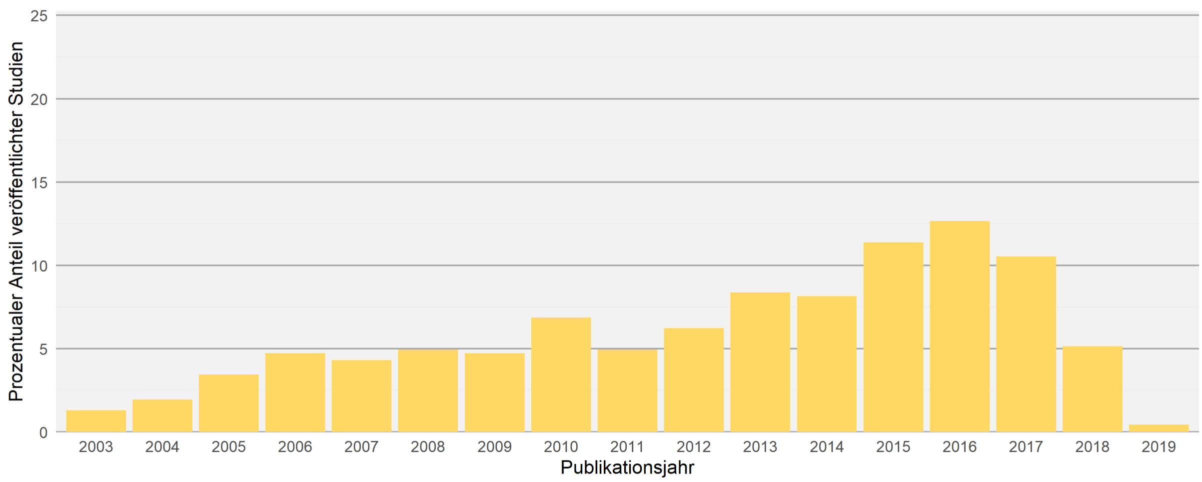
Region (Land)	**Anzahl**
Europa (Belgien: 2, Dänemark: 8, Deutschland: 15, Europa: 7, Finnland: 5, Frankreich: 9, Griechenland: 4, Irland: 1, Italien: 23, Kosovo: 1, Litauen: 1, Mittelmeerregion: 1, Niederlande: 5, Norwegen: 3, Österreich: 1, Polen: 1, Portugal: 1, Russland: 1, Schweden: 10, Serbien: 3, Spanien: 10, Türkei: 1, Vereinigtes Königreich: 19)	132
Ozeanien (Australien: 6, Neuseeland: 1)	7
global	1
Total	**466**

Die Veröffentlichung der Studien war gemäß Suchprotokoll nach 2003 mit einer Zunahme der Anzahl nach 2013 (Tabelle 23, Abbildung 14).

Tabelle 23: Jahr der Veröffentlichung der Studien zu Umwelteinflüssen durch Luftbelastungen

Jahr	Anzahl	Jahr	Anzahl	Jahr	Anzahl	Jahr	Anzahl	Jahr	Anzahl
2003	6	2007	20	2011	23	2015	53	2019	2
2004	9	2008	23	2012	29	2016	59		
2005	16	2009	22	2013	39	2017	49		
2006	22	2010	32	2014	38	2018	24		

Abbildung 14: Jahr der Veröffentlichung der Studien zu Umwelteinflüssen durch Luftbelastungen



Quelle: eigene Darstellung BioMath GmbH

In den 466 Studien wurden die Auswirkungen von Benzol, Bioaerosolen, Feinstaub, Ozon, Schwermetallen, Stickstoffdioxiden und VOC auf Gesundheitsinfrastruktur, Morbidität und Mortalität betrachtet (Tabelle 24).

Tabelle 24: Anzahl identifizierter Studien zu Vulnerabilität (Outcome) bei Luftbelastungen (Exposition)

Outcome	Exposition							
	Benzol	Bioaerosole	Feinstaub	Ozon	Schwermetalle	Stickstoffdioxid	VOC	Gesamtergebnis
Gesundheitsinfrastruktur	**0**	**0**	**81**	**0**	**0**	**2**	**0**	**83**
E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten			2					**2**
G00-G99 Krankheiten des Nervensystems			1					**1**
H60-H95 Krankheiten des Ohres und des Warzenfortsatzes			1					**1**
I00-I99 Krankheiten des Kreislaufsystems			37			1		**38**
J00-J99 Krankheiten des Atmungssystems			21					**21**
K00-K93 Krankheiten des Verdauungssystems			2					**2**
M00-M99 Krankheiten des Muskel-Skelett-Systems und des Bindegewebes						1		**1**
R50-R69 Allgemeinsymptome			1					**1**
Diverse			16					**16**
Morbidität	**0**	**7**	**160**	**6**	**18**	**25**	**1**	**217**
A00-B99 Bestimmte infektiöse und parasitäre Krankheiten		3						**3**
C00-D48 Neubildungen			9	1	1	2		**13**
E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten			6		1			**7**
F00-F99 Psychische und Verhaltensstörungen			12		4	3		**19**
G00-G99 Krankheiten des Nervensystems			8		2			**10**
H00-H59 Krankheiten des Auges und der Augenanhangsgebilde						1		**1**
H60-H95 Krankheiten des Ohres und des Warzenfortsatzes					1			**2**
I00-I99 Krankheiten des Kreislaufsystems			66	2	5	8		**81**
J00-J99 Krankheiten des Atmungssystems		4	38	3		7	1	**53**

Outcome	**Exposition**							
	Benzol	**Bioaerosole**	**Feinstaub**	**Ozon**	**Schwermetalle**	**Stickstoffdioxid**	**VOC**	**Gesamtergebnis**
K00-K93 Krankheiten des Verdauungssystems						1		**1**
L00-L99 Krankheiten der Haut und der Unterhaut			2					**2**
M00-M99 Krankheiten des Muskel-Skelett-Systems und des Bindegewebes			3		3			**6**
N00-N99 Krankheiten des Urogenitalsystems			1					**1**
R00-R99 Symptome und abnorme klinische und Laborbefunde, die anderenorts nicht klassifiziert sind			2					**2**
Sonstige			6		1	3		**10**
Diverse			7					**7**
Mortalität	2	**0**	**142**	**10**	**4**	**7**	**1**	**166**
C00-D48 Neubildungen	2		2		1			**5**
E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten			2					**2**
I00-I99 Krankheiten des Kreislaufsystems			44	2	1			**47**
J00-J99 Krankheiten des Atmungssystems			19			2	1	**21**
N00-N99 Krankheiten des Urogenitalsystems					1			**1**
S00-T98 Verletzungen, Vergiftungen und bestimmte andere Folgen äußerer Ursachen						1		**1**
Sonstige			2					**2**
Diverse			74	8	1	4		**87**
Gesamtergebnis	**2**	**7**	**384**	**16**	**22**	**34**	**1**	**466**

Von den 466 Studien stellten 371 (80 %) eine erhöhte Vulnerabilität exponierter älterer Menschen im Vergleich zu nichtexponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen fest, 36 Studien (8 %) fanden keine Unterschiede und 59 Studien (12 %) stellten eine geringere Vulnerabilität im Vergleich zu anderen Altersklassen fest (Tabelle 25).

Tabelle 25: Ergebnisse der Studien zu Umwelteinflüssen durch Luftbelastungen

Effekt	Code	Anzahl
Exponierte ältere Menschen sind vulnerabler im Vergleich zu nichtexponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen	+	371
Keine Unterschiede zwischen den Gruppen	0	36
Exponierte ältere Menschen sind weniger vulnerabel im Vergleich zu nichtexponierten älteren Menschen und/oder im Vergleich zu exponierten jüngeren Menschen	-	59

Zwei Studien konnten mit dem höchsten Summenqualitätsscore ++++ bewertet werden. Elf Studien wurden mit +++ bewertet, wobei bei zehn Studien die Exposition nicht kontrolliert wurde und bei einer Studie keine Vergleichsgruppe vorhanden war. 98 Studien erhielten den Gesamtscore ++, 283 Studien den Gesamtscore +. 72 Studien erfüllten keines der vier Qualitätskriterien (Tabelle 26). Die kontrollierte Exposition ist das Qualitätskriterium, das von den wenigsten Studien erfüllt wird.

Tabelle 26: Qualität der Studien zu Umwelteinflüssen durch Luftbelastungen

	Qualitätskriterium				
Kombinationsscore	**Studientyp**	**kontrollierte Exposition**	**Einzeldaten**	**Vergleichsgruppe**	**Anzahl Studien**
++++	+	+	+	+	**2**
+++	+	-	+	+	**10**
+++	+	+	+	-	**1**
++	-	-	+	+	**95**
++	+	-	-	+	**1**
++	+	-	+	-	**2**
+	-	-	-	+	**185**
+	-	-	+	-	**98**
	-	-	-	-	**72**
Anzahl Studien, die das Qualitätskriterium erfüllen (+)	**16**	**3**	**208**	**293**	**466**

Im Folgenden wird eine Zusammenfassung der Ergebnisse gegeben. Einzelheiten zu jeder Studie inklusive Ergebnis- und Qualitätsbewertung finden sich im Anhang B.4.

4.5.1 Ausgewählte infektiöse und parasitäre Krankheiten

Ein signifikant höheres Risiko für Pontiac-Fieber durch Legionellen wurde bei älteren Personen über 80 Jahren beobachtet, die eine Corticosteroid-Therapie erhielten (Bauer et al., 2008). Personen unter 60 Jahren sind vulnerabler im Vergleich zu über 60-Jährigen gegenüber der

Erkrankung Onychomykose (Soltani et al., 2015). Die Prävalenz nimmt mit zunehmendem Alter ab über 65 Jahren ab und ist bei über der Hälfte der Fälle mit systemischen Erkrankungen assoziiert (Yoo et al., 2014).

4.5.2 Neubildungen

Micheli et al. (2014) sehen einen Zusammenhang zwischen der Exposition gegenüber Benzol bei über 75-Jährigen und einem erhöhten Risiko an malignen hämatologischen Erkrankungen in Bezug auf die Nähe der Wohnung zur Raffinerie zu sterben.. Die Exposition gegenüber Benzol erhöht das Risiko im Alter (bei über 45 bis 65 Jahren) an Leukämie zu erkranken (Richardson, 2008).

Für das Überleben von Eierstockkrebs (definiert als die Zeit zwischen Diagnose und Tod durch Eierstockkrebs oder das Datum der letzten Nachuntersuchung) bei über 65-jährigen Frauen scheinen Umweltverschmutzungen und /oder sozioökonomische Belastung negativ beizutragen (Vieira et al., 2017).

Das Brustkrebsrisiko bei postmenopausalen Frauen scheint nicht mit Cadmium im Urin assoziiert zu sein, auch nicht bei Raucherinnen und Frauen mit einem Body-Mass-Index von weniger als 25 (Adams et al., 2016). Die im Urin gemessene Cadmium-Exposition scheint mit der Mortalität durch alle Krebsarten, insbesondere durch Lungen- und Bauchspeicheldrüsenkrebs und Krebs verursacht durch Tabakerzeugnisse bei älteren Menschen assoziiert zu sein (García-Esquinas et al., 2014).

Bidoli et al. (2015) können kein höheres Lungenkrebsrisiko bei über 75-Jährigen im Vergleich zu unter 75-Jährigen durch Stickstoffdioxid finden, jedoch ein erhöhtes Risiko bei Frauen und Männern unter 75 Jahren. Ein erhöhtes Risiko für Prostatakrebs in Assoziation mit Stickstoffdioxid bei Menschen unter 75 Jahren beobachten Parent et al. (2013).

Chen et al. (2008), Pan et al. (2015), Myneni et al. (2013), Turner et al. (2011), Brenner et al. (2010), Collarile et al. (2017), Bidoli et al. (2016), Guo et al. (2016) und Li et al. (2013) berichten von erhöhter Lungenkrebs-Mortalität sowie -Morbidität bei älteren Personen infolge einer Exposition gegenüber Feinstaub.

4.5.3 Endokrine, Ernährungs- und Stoffwechselkrankheiten

Tsaih et al. (2004) beobachten eine Wechselwirkung von im Blut und Knochen gemessenem Blei und dem Auftreten von Diabetes, wodurch eine signifikante Erhöhung des Serumkreatinins bei männlichen Personen über 60 Jahren in Erscheinung tritt. Hiermit vergesellschaftet scheint ein Rückgang der Nierenfunktion bei älteren Menschen, wobei Personen mit Diabetes mellitus und Hypertonie stärker betroffen sind.

Diabetes-bedingte Krankenhauseinweisungen beobachten Sun et al. (2016) in Assoziation mit PM2.5-, PM10- und CO-Konzentrationen bei älteren Menschen über 65 Jahren und Song et al (2018) insbesondere bei männlichen Personen, auch in der jüngeren Altersklasse unter 65 Jahren. Die kurzfristige Exposition gegenüber einigen chemischen Bestandteilen von PM10 wie Nitrat und elementarem Kohlenstoff erhöht das Risiko bei über 65-Jährigen für akute Komplikationen oder eine Verschlimmerung der Symptome bei Diabetes mellitus Typ2-PatientInnen (Sun et al., 2016).

Verschiedene Autoren beobachteten einen Zusammenhang der Exposition gegenüber Feinstaub bzw. der Exposition gegenüber Verkehrsschadstoffen mit der Verbreitung von Diabetes bei älteren Menschen: Wallwork et al. (2016): Altersgruppe: 70 Jahre; Liu et al. (2016): Altersgruppe: 60 Jahre; Pettit et al. (2015): Altersgruppe: 61 Jahre; Kim et al. (2012):

Altersgruppe: >60 Jahre und Park et al. (2015): Altersgruppe: 64 Jahre[4]. Keinen gesicherten Zusammenhang sehen dagegen Dijkema et al. (2011) in diversen Altersgruppen zwischen 50 und 65 Jahren.

Eine erhöhte Mortalität im Zusammenhang mit Luftverschmutzung verzeichnen Huang et al. (2012) und Brook et al. (2013) bei Menschen über 65 Jahren.

4.5.4 Psychische und Verhaltensstörungen

Sun et al. (2008), Tallon et al. (2017), Ailshire et al. (2014) und Tonne et al. (2014) beobachten bei über 65-Jährigen erhöhte Schwierigkeiten bei Aktivitäten des täglichen Lebens (u. a. beim Baden, Anziehen, Essen) und kognitive Einschränkungen im Zusammenhang mit erhöhter Luftverschmutzung. Wellenius et al. (2012) sehen ein erhöhtes Risiko für ältere Menschen über 65 Jahren, durch die Wohnnähe zu Hauptverkehrsstraßen kognitive Beeinträchtigungen mit Auswirkungen auf bestimmte Bereiche des Gehirns zu erleiden. Wang et al. (2014) finden keinen Zusammenhang zwischen der Langzeitverkehrsexposition und Depressionen bei Älteren. Ein erhöhtes Stressempfinden sowie die Anzahl an Depressionssymptomen stehen im Zusammenhang mit der Exposition gegenüber Feinstaub (Kim et al., 2017 und Lim et al., 2012). Kioumourtzoglou et al. (2017) stellen bei älteren Menschen einen erhöhten Verbrauch an Antidepressiva bei erhöhten Feinstaub- und Ozonwerten fest. Ein Ozon-Anstieg ist assoziiert mit einem Anstieg von Apnoen und Hypopnoen (Weinreich et al., 2015) sowie Angstzuständen (Power et al., 2015). Oudin et al. (2016) sehen die Luftverschmutzung als bedeutenden Risikofaktor für Alzheimer.

Bei Kindern und Erwachsenen über 60 Jahren variiert die Beziehung zwischen dem toxischen Serumhomocysteinspiegel im Blut und der Blutbleikonzentrationen je nach VDR-Genotyp. Einen Zusammenhang der kognitiven Leistung mit der Blutbleikonzentration bei über 60-Jährigen konnte jedoch nicht festgestellt werden (Krieg et al., 2010). Die Exposition gegenüber Blei scheint mit einer erhöhten Wahrscheinlichkeit für psychiatrische Symptome bei männlichen Personen über 65 Jahren assoziiert zu sein (Rajan et al., 2007). Zudem scheint Blei bestimmte neuronale Lernmechanismen bei älteren Männern über 70 Jahren zu beeinträchtigen, konstatieren Grashow et al. (2013) und van Wijngaarden et al. (2009).

Gegenüber der Exposition mit Stickstoff sind ältere Männer über 65 Jahren vulnerabler im Zusammenhang mit Stresssymptomen im Vergleich zu Frauen der gleichen Altersklasse (Hwang et al., 2018). Insbesondere Menschen mit Wohnorten in ländlichen Gebieten scheinen anfälliger im Vergleich zur städtischen älteren Bevölkerung in Bezug auf ihre mentale Gesundheit. Beispielsweise sind depressive Symptome mit der Konzentration der Luftschadstoffe insbesondere bei Menschen mit chronischen Erkrankungen assoziiert (Tian et al., 2015 und Wang et al., 2018).

4.5.5 Krankheiten des Nervensystems

Weisskopf et al. (2010) beschreiben eine positive Assoziation einer zunehmenden Bleibelastung gemessen im Tibia-Knochen mit dem Auftreten der Parkinson-Krankheit bei über 60-Jährigen. Coon et al. (2006) sehen hingegen das Risiko für die Parkinson-Krankheit bei älteren über 70 Jahren im Zusammenhang mit der Bleibelastung nicht signifikant erhöht im Vergleich zu jüngeren Menschen unter 70 Jahren.

Keinen Zusammenhang zwischen der Feinstaubbelastung und der Parkinson-Krankheit sehen Palacios et al. (2017). Chen et al. (2017) konstatieren, dass nur PM10 bei zusätzlicher

[4] angegeben sind Durchschnittswerte

Komorbidität die Inzidenz der Parkinson-Krankheit signifikant beeinflusst. Andere AutorInnen beobachten Zusammenhänge mit der Exposition gegenüber Ozon (Kirrane et al., 2015), der Exposition gegenüber Stickstoffdioxid (Lee et al., 2016) und der Exposition gegenüber PM2.5, NO2 und CO (Lee et al., 2017), insbesondere für Ältere.

Wilker et al. (2015) beschreiben ein kleineres Hirnvolumen bei über 60-Jährigen nach der Langzeitexposition mit Feinstaub. Auch Chen et al. (2015) fanden bei Frauen über 70 Jahren mit höherer Exposition gegenüber PM2.5 ein kleineres Volumen der weißen, aber nicht der grauen Substanz. Einen Zusammenhang zwischen der Exposition gegenüber PM2.5 und dem Karpaltunnelsyndrom fanden Weng et al. (2017).

Krankenhauseinweisungen aufgrund von neurologischen Erkrankungen (Demenz, Alzheimer-Krankheit und Parkinson-Krankheit) scheinen bei über 65-jährigen Menschen signifikant im Zusammenhang mit der Luftverschmutzung zu stehen (Kioumourtzoglou et al., 2016).

4.5.6 Krankheiten des Auges und der Augenanhangsgebilde

Ältere Frauen über 64 Jahren haben im Vergleich zu jüngeren und zu männlichen Personen aller Altersgruppen ein höheres Konjunktivitisrisiko im Zusammenhang mit der Exposition gegenüber Stickstoffdioxid (Chiang et al., 2012).

4.5.7 Krankheiten des Ohres und des Warzenfortsatzes

Personen über 60 Jahren scheinen im Vergleich zu jüngeren Personen ein erhöhtes Risiko für Krankenhausbesuche aufgrund von Morbus Menière im Zusammenhang mit der Exposition gegenüber Feinstaubpartikeln aufzuzeigen (Han et al., 2017).

Huh et al. (2016) liefern Hinweise darauf, dass die Verwendung von Kopfhörern und bereits eine gering erhöhte Blei-Exposition individuell das Risiko eines Hörverlusts bei jüngeren und älteren Menschen über 60 Jahren erhöhen könnte.

4.5.8 Krankheiten der Haut und der Unterhaut

Hüls et al. (2016) sehen einen starken Zusammenhang zwischen Altersflecken und der Exposition gegenüber Stickstoffdioxid, insbesondere bei Frauen ab 50 Jahren. Vierkötter et al. (2010) beobachten eine Zunahme der äußerlichen Hautalterung bei Personen ab 70 Jahren durch die Exposition verkehrsbedingter Luftverschmutzung.

4.5.9 Krankheiten des Kreislaufsystems

Wellenius et al. (2005), Ukëhaxhaj et al. (2013), Vahedian et al. (2017), Wang, et al. (2015), Zhang et al. (2016), Jalaludin et al. (2006), Weichenthal et al. (2017), Wang et al. (2015), Tian et al. (2017), Chen et al. (2014), Zanobetti et al. (2005) und Wichmann et al. (2014) beobachten eine steigende Anzahl an Krankenhauseinlieferungen von Älteren aufgrund von Herzinfarkt durch eine erhöhte Exposition gegenüber Feinstaub und/oder dessen Teilkomponenten (PM, CO, NO2, SO2).

Auch Zhao et al. (2014), Xie et al. (2014), Xu et al. (2017), Nascimento (2011), Fung et al. (2005), Cox et al. (2017), Solimini et al. (2017), Wichmann et al. (2013), Buadong et al. (2009), Wettstein et al. (2018), Yorifuji et al. (2014), Peng et al. (2009), Maheswaran et al. (2005), Rosenthal et al. (2008), Colais et al. (2012), Wellenius et al. (2006, 2005), Larrieu et al. (2007), Ma et al. (2017), Zheng et al. (2005), Martins et al. (2006), Barnett et al. (2006), Chan et al. (2006) und Koken et al. (2003) sehen einen Zusammenhang zwischen einer vermehrten Anzahl an Arztbesuchen und/oder Krankenhauseinlieferungen von Älteren aufgrund von Erkrankungen des Herz- und

Kreislaufsystems (u.a. Herzrhythmusstörungen) und der Exposition gegenüber erhöhten Schadstoffkonzentrationen.

Die Anfälligkeit für Herz- und Kreislauferkrankungen bei hoher Feinstaubbelastung scheint nach Ye et al. (2016) bei älteren Männern besonders hoch zu sein, wogegen Hart et al. (2015) und Kowalska et al. (2012) ältere Frauen besonders gefährdet sehen. Viele Studien beobachten bei älteren Menschen einen Zusammenhang zwischen der erhöhten Exposition gegenüber Feinstaub und dem Auftreten von Herz- und/oder Kreislauferkrankungen wie Atherosklerose und Herzinfarkt (Hartiala et al., 2016; Yue et al., 2007; Kaelsch et al., 2014; Kojima et al., 2017; Kaufman et al., 2016; McGuinn et al., 2016; Hennig et al., 2014; Zhao et al., 2015; Lipsett et al., 2006; Liu et al., 2009; Qiu et al., 2017; Banerjee et al., 2012; Fuks et al., 2011; Chen et al., 2014; Sohn et al., 2016; Chen et al., 2014, Delfino et al., 2010; Peters et al., 2013; Bauer et al., 2010; Chahine et al., 2003; Holguín et al., 2003; Auchincloss et al., 2008; Halonen et al., 2009; Bartell et al., 2013; insbesondere über lange Zeiträume konstatieren Chen, Szu-Ying et al. (2015), Panasevich et al. (2009), Schneider et al. (2010), Sørensen et al. (2014), Dubowsky et al. (2006), Adar et al. (2013), Goncalves et al. (2007), Panasevich et al. (2013), Levinsson et al. (2014), Pope et al. (2006), Stafoggia et al. (2014), Mordukhovich et al. (2016) oder bei Vorliegen einer Diabetes Erkrankung beobachten O'Donnell et al. (2011), Hart et al. (2015) und Whitsel et al. (2009).

Ebenso wird bei älteren Menschen ein Zusammenhang zwischen der erhöhten Exposition gegenüber Feinstaub und der Anzahl an Todesfällen aufgrund von Herz- und Kreislauferkrankungen geschlussfolgert (Forastiere et al., 2005; Lo et al., 2017; Berglind et al., 2009; Chen et al., 2010; Luo et al., 2016; Su et al., 2015; Liu et al., 2015; Zhang et al., 2017; Cappellari et al., 2017; Gan, Wen et al., 2012; Kettunen et al., 2007; Gutierrez-Avila et al., 2018; Hart et al., 2013; Puett et al., 2009; Delfino et al., 2008; Qian et al., 2013; Wong et al., 2014; Maheswaran et al., 2010; Yamazaki et al., 2007; Tonne, Cathryn et al., 2013; Rodrigues et al., 2018; Milojevic et al., 2014; Jerrett et al., 2013; Revich et al., 2010; Raaschou-Nielsen et al., 2012).

Keinen Zusammenhang zwischen der Exposition gegenüber Feinstaub und dem Auftreten von Herzinfarkten und kardiovaskulären Erkrankungen und eine daraus resultierende erhöhte Anzahl an Krankenhauseinweisungen sehen McClure et al. (2017), Host et al. (2008), Chung et al. (2015), Dastoorpoor et al. (2018), Puett et al. (2011) und Stankovi et al. (2007). Diez Roux et al. (2008), Bjor et al. (2010) und Wilker et al. (2013) konstatieren, dass ältere Menschen keine besondere Vulnerabilität aufweisen. Dagegen sehen Sade et al. (2015), Yitshak Sade et al. (2015), Zhang et al. (2016), Hoffmann et al. (2007), Sen et al. (2016), Gan et al. (2010), Ueda et al. (2009) ein höheres Herzinfarktrisiko bei jüngeren Erwachsenen bzw. keine unterschiedlichen Risiken.

Die meisten Herz-Kreislauf-Beschwerden treten bei Älteren 1 bis 3 Tage nach Ereignissen hoher Luftbelastungen ein (Rückerl et al., 2006; Xia et al., 2017; Kashima et al., 2017; Mcbride et al., 2011; Haikerwal et al., 2015; Chen et al., 2012; Ensor et al., 2013).

Shih et al. (2011) schlussfolgern, dass das Risiko venöser Thromboembolien nicht mit der Exposition gegenüber Feinstaub zusammenhängt.

Es scheint ein positiver Zusammenhang zwischen der Exposition gegenüber Ozon und dem Auftreten eines ischämischen Schlaganfalls bei Männern über 70 Jahren zu bestehen (Henrotin et al., 2007). Xu et al. (2013) konnten anhand der Anzahl an Schlaganfall-bedingten Krankenhauseinweisungen bei männlichen Personen über 65 Jahren feststellen, dass diese im Vergleich zu über 65-jährigen Frauen anfälliger auf die Exposition gegenüber Ozon reagieren.

Ebenso scheint es einen Zusammenhang zwischen der kardiorespiratorischen Mortalität und der Ozonbelastung zu geben bei Personen über 65 Jahren im Vergleich zu der erwachsenen Bevölkerung unter 65 Jahren (Halonen et al., 2010). Parodi et al. (2005) weisen einen signifikanten Zusammenhang in Bezug auf die Exposition gegenüber Ozon in der warmen und kalten Jahreszeit und der kardiovaskulären Mortalität bei über 75-jährigen Personen im Vergleich zu der Gesamtbevölkerung nach.

Tellez-Plaza et al. (2010) beobachten insbesondere bei Männern über 65 Jahren einen Zusammenhang zwischen der Prävalenz der peripheren arteriellen Erkrankung und dem Cadmiumspiegel im Urin und Blut. Myong et al. (2014) sehen ebenso einen Zusammenhang zwischen der Exposition gegenüber Cadmium bei Männern im Alter von 60 bis 65 Jahren und dem Risiko für koronare Herzerkrankungen. Sponder et al. (2014) sehen hingegen keinen Zusammenhang bei über 60-Jährigen, dass der Urincadmiumspiegel und die Blutspiegel von Quecksilber oder Blei eine wichtige Rolle bei der Entstehung von koronaren Herzkrankheiten spielen. Die Cadmiumbelastung scheint das Risiko für die kardiovaskuläre Mortalität und kardiovaskuläre Erkrankungen, koronare Herzerkrankungen, das Auftreten von Schlaganfällen und dem Entstehen einer Herzinsuffizienz bei über 60-Jährigen zu erhöhen (Tellez-Plaza et al., 2013). Lind et al. (2012) stellen fest, dass erhöhte Expositionen gegenüber Kupfer und Nickel bei älteren Erkrankten im Alter von 70 Jahren mit linksventrikulärer Hypertrophie in Verbindung stehen könnten.

Villeneuve et al. (2006) und Andersen et al. (2012) können kein höheres Schlaganfallrisiko durch erhöhte Expositionen gegenüber Stickstoffdioxid in den Luftverschmutzungen durch alle Jahreszeiten hinweg sehen. Bodin et al. (2016) können ebenso auch kein höheres Herzinfarktrisiko durch die Exposition gegenüber Luftverschmutzungen sehen. Es wurde ebenso kein Zusammenhang einer kontrollierten Kurzeit-Exposition bei über 60-Jährigen und einer Veränderung der Herzratenvariabilität und des Blutdrucks gefunden laut Routledge et al. (2006).

Huang et al. (2017), Vidale et al. (2010) und Rivera et al. (2013) finden Assoziationen zwischen der Schlaganfallsmortalität und der Anzahl an Krankenhauseinweisungen bei über 65-Jährigen und in warmen Jahreszeiten aufgrund der Exposition gegenüber der Luftverschmutzung in Verbindung mit Stickstoffdioxid. Positive Assoziation zwischen verkehrsbedingten Luftschadstoffen und einer Erhöhung des systolischen und diastolischen Blutdrucks bzw. akuten Koronarsyndrom bei älteren Männern finden auch Schwartz et al. (2012) bzw. Vencloviene et al. (2011).

4.5.10 Krankheiten des Atmungssystems

Frauen über 60 Jahren, die Kochdämpfen ausgesetzt waren, haben ein erhöhtes Risiko an chronischer Bronchitis zu erkranken (Chen et al., 2018). Guilbert et al. (2018) beobachten einen Anstieg der Asthma-bedingten Krankenhausaufenthalte durch die Exposition gegenüber Gras-, Birken- und Hainbuchen-Pollen bei unter 60-Jährigen, nicht aber bei über 60-Jährigen. Zhang et al. (2012) zeigen einen Zusammenhang zwischen der Pollenkonzentration in der Umgebungsluft und der Anzahl der Konsultationen bei allergischer Rhinitis bei Personen unter 60 Jahren, ältere Menschen über 60 Jahren weisen deutlich weniger ambulante Besuche auf. Es wurden keine signifikanten Zusammenhänge zwischen Mehltau-Geruch oder muffigem Geruch in Innenräumen und Harnkonzentrationen von Umweltchemikalien bei älteren Menschen über 60 Jahren festgestellt (Shiue 2015).

Eine erhöhte Anzahl von Notfällen älterer Menschen aufgrund von Atemwegserkrankungen bei erhöhter Exposition gegenüber Feinstaub zeigen Wang et al. (2015), Guo et al. (2014), Tao et al.

(2012), Bell et al. (2014), Michikawa et al. (2015), Xu et al. (2016), Chen et al. (2004), Neupane et al. (2010), Son et al. (2013), Medina-Ramón et al. (2006), Smargiassi et al. (2006), Tramuto et al. (2011), Halonen et al. (2008) und Liu et al. (2017). Keine Altersunterschiede fanden Dirks et al. (2017) und Sousa et al. (2012).

Ein höheres Risiko bei erhöhter Exposition gegenüber Feinstaub wird für Jüngere bzw. Kinder im Vergleich zu Älteren in der Anzahl von Notfällen aufgrund von Atemwegserkrankungen aufgezeigt von Ko et al. (2007) und Liu et al. (2016). Keinen Zusammenhang zwischen der Feinstaubbelastung und den Arztbesuchen aufgrund von Atemwegserkrankungen sehen Chang et al. (2017), Salimi et al. (2018) und Morgan et al. (2018).

Einen Zusammenhang zwischen der Exposition gegenüber Feinstaub und dem Auftreten von Atemwegserkrankungen bei Älteren beschreiben Craig et al. (2008), Adar et al. (2007), Sanchez-Soberon et al. (2015), Wang et al. (2013), Miguel-Díez et al. (2016), Liu et al. (2017); Zhou et al. (2017), Bentayeb et al. (2010), Nkosi et al. (2015), Cortez-Lugo et al. (2015), Jo et al. (2017), Sichletidis et al. (2014), Annesi-Maesano et al. (2013), Bentayeb et al. (2015), Kaji et al. (2014), Peacock et al. (2011), Epstein et al. (2012), Sichletidis et al. (2005), Santurtún et al. (2017), McCormack et al. (2016), Boezen et al. (2005), Ding et al. (2015), Nakao et al. (2018) und Mishra (2003).

Schikowski et al. (2014), Hsu et al. (2011), Namdeo et al. (2011), Hansel et al. (2013), Villeneuve et al. (2006), Atkinson et al. (2015) und Smith et al. (2014) sehen hingegen keinen klaren Zusammenhang zwischen der Exposition gegenüber Feinstaub und dem Auftreten von Atemwegserkrankungen bei Älteren. Eine erhöhte Vulnerabilität im Vergleich zu anderen Altersgruppen wurde von Feng et al. (2016), Zhang et al. (2013) und Matthews et al. (2016) nicht beobachtet.

Eine erhöhtes Mortalitätsrisiko aufgrund von Atemwegserkrankungen im Zusammenhang mit der Exposition gegenüber Feinstaub bei Älteren verzeichnen Sahani et al. (2014), Faustini et al. (2013), Dimakopoulou et al. (2014), Gan et al. (2013), Oliveira et al. (2011), Faustini et al. (2016), Martins et al. (2004), Zanobetti et al. (2008), Xue et al. (2018), Vodonos et al. (2016), Faustini et al. (2011), Li et al. (2017) und Sun et al. (2019). Einen Rückgang der Mortalitätsrate aufgrund von Atemwegsinfekten bei Älteren über 70 Jahren zeigen Troeger et al. (2018). O'Neill et al. (2008); Hajat et al. (2005) und Palmer et al. (2009) sehen keinen Zusammenhang in Bezug erhöhter Mortalitätszahlen bei älteren Personen und dem Auftreten von Atemwegserkrankungen im Zusammenhang mit der Exposition gegenüber Feinstaub.

Magzamen et al. (2017) und Luong et al. (2018) zeigen, dass über 65-jährige Personen vulnerabler als jüngere Altersklassen bzw. Kinder sind anhand der Anzahl der Krankenhauseinweisungen durch respiratorische Erkrankungen in Assoziation mit Ozon. Hingegen sind über 65-Jährige weniger vulnerable als Kinder, konstatieren Luong et al. (2018) in Bezug auf Krankenhauseinweisungen durch respiratorische Erkrankungen in Assoziation mit Ozon zu allen Jahreszeiten. Keinen Unterschied zwischen den Altersklassen unter 65 Jahren und über 65 Jahren zeigen die AutorInnen Jung et al. (2016) zwischen der Exposition gegenüber Ozon und der Lungenfunktion in verschiedenen Altersklassen.

Hohe Assoziation zwischen dem Auftreten von Todesfällen aufgrund von respiratorischen Erkrankungen bei über 60-Jährigen im Vergleich zu anderen Altersklassen im Zusammenhang mit der Exposition gegenüber verkehrsbedingten Luftschadstoffen und insbesondere Stickstoffdioxid finden César et al. (2015) und Ren et al. (2017). Einen Aufwärtstrend bei asthmabedingten Krankenhausaufenthalten bei über 64-Jährigen, insbesondere bei Frauen, durch die Exposition gegenüber Stickstoffdioxid und Kohlenmonooxid zeigen Altzibar et al. (2015), Andersen et al. (2012) und Andrea Rodriguez-Villamizar et al. (2018).

Nuvolone et al. (2011) konstatieren, dass ältere Frauen näher an der Hauptstraße als jüngere Frauen leben und tendenziell einen niedrigeren sozioökonomischen Status zu haben scheinen als Frauen, die weiter entfernt leben. Dadurch haben die Älteren ein erhöhtes Risiko für verschiedene respiratorische Erkrankungen, wie Dyspnoe oder Asthma u.a., schlussfolgern die Autoren. Eine signifikante Wechselwirkung zwischen der Luftqualität und Krankenhausaufenthalten aufgrund von Lungenentzündungen bei über 65-Jährigen zeigen Tam et al. (2017). Eine steigende Anzahl an Krankenhauseinweisungen durch respiratorische Erkrankungen in Assoziation mit Schwefeldioxid und Ozon und anderen Wettervariablen in allen Jahreszeiten zeigen auch Wilson et al. (2005) bei 65-Jährigen, jedoch nicht im Vergleich zu anderen Altersklassen. Yamazaki et al. (2014) konnten keinen gesicherten Zusammenhang der Expositionen gegenüber der täglichen mittleren PM2.5-Konzentration und nächtlichen asthmabedingten Notarztbesuchen bei Kindern und Älteren über 65 Jahren nachweisen.

Bentayeb et al. (2013) konnten signifikante Assoziationen zwischen Wohnungen mit erhöhten Toluol- bzw. o-Xylol-Konzentrationen und dem Auftreten von Atemnot bei älteren Menschen im Vergleich zu der übrigen Bevölkerung finden.

4.5.11 Krankheiten des Verdauungssystems

Einen Zusammenhang zwischen erhöhten Expositionen gegenüber Stickstoffdioxid und dem Auftreten von Magengeschwüren bei über 65-Jährigen finden Tian et al. (2017) und Wong et al. (2016). Kaplan et al. (2010) fanden keinen Zusammenhang zwischen der Exposition gegenüber NO_2, SO_2 und PM10 und dem Auftreten von entzündlichen Darmerkrankungen bei Personen über 58 Jahren.

4.5.12 Krankheiten des Muskel-Skelett-Systems und des Bindegewebes

Prada et al. (2017) und Alver et al. (2010) weisen bei 65-Jährigen ein erhöhtes Risiko von Knochenbrüchen in Gegenden mit hohen PM2.5-Konzentrationen nach. Die Knochenmineraldichte bei 75-76-Jährigen hängt mit der Umweltverschmutzung zusammen konstatieren Alvaer et al. (2007). Erhöhte Bleigehalte, die im Tibia-Knochen gemessen wurden, scheinen mit einer höheren Knochenmineraldichte bei älteren Frauen assoziiert zu sein schlussfolgern Theppeang et al. (2008) und zeigen, dass die Auswirkungen auf Veränderungen der Bleikinetik im Alter durch eine erheblichen Bleiexposition im frühen und mittleren Lebensalter bei älteren Menschen verbunden sind.

Garcia-Esquinas et al. (2015) sehen eine positive Assoziation zwischen einer erhöhten Bleikonzentration im Blut, jedoch nicht Cadmium im Urin, und der Gebrechlichkeit (Erschöpfung, niedriges Körpergewicht, geringe körperliche Aktivität, Schwäche und langsame Gehgeschwindigkeit) in der älteren Bevölkerung über 60 Jahren. Kim et al (2014) stellen fest, dass die Cadmium-Werte im Urin bei weiblichen Personen höher sind als bei männlichen Personen im Alter von über 60 Jahren, wodurch insbesondere bei Frauen eine Schädigung der Nierenmikrotubuli und dann eine Manifestation einer Osteoporose diskutiert wird.

Eine höhere Vulnerabilität gegenüber der Exposition mit Luftschadstoffen und dem Auftreten von Hüftfrakturen bei Frauen, Männern und über 75-Jährigen im Vergleich zu unter 75-Jährigen stellen Mazzucchelli et al. (2018) fest.

4.5.13 Krankheiten des Urogenitalsystems

Ein hoher Bleigehalt im Blut scheint das Risiko für die Gesamtmortalität, die kardiovaskuläre Mortalität und die infektionsbedingte Mortalität bei Personen über 60 Jahren, die in ärztlicher Behandlung mit einer Erhaltungshämodialyse sind, zu erhöhen (Lin et al., 2011). Es wurde bei unter 65-jährigen Personen im Vergleich zu über 65-Jährigen eine Assoziation zwischen dem Anstieg der PM10-Konzentration und der glomerulären Filtrationsrate sowie dem Auftreten von chronischen Nierenerkrankungen gezeigt (Yang et al., 2017).

4.5.14 Symptome und abnorme klinische und Laborbefunde, die anderenorts nicht klassifiziert sind

Ng et al. (2016) und Kim et al. (2010) sehen eine Verbindung zwischen der Exposition gegenüber Luftschadstoffen und der Selbstmordrate, insbesondere bei älteren Frauen.

4.5.15 Verletzungen, Vergiftungen und bestimmte andere Folgen äußerer Ursachen

Zusammenhänge zwischen der Exposition gegenüber Luftschadstoffen und dem Risiko durch unbeabsichtigte Verletzungen (Stürze, Brände, Ersticken, Ertrinken, Exposition gegenüber Umwelteinflüssen u.a.) zu sterben, sehen Ha et al. (2015) bei über 60-Jährigen, insbesondere bei Männern.

4.5.16 Sonstige (keine Spezifizierung der Krankheit)

Cesaroni et al. (2010) beobachten Zusammenhänge zwischen der Exposition gegenüber verkehrsbedingter Luftverschmutzung und der höchsten Anzahl an Krankenhauseinweisungen bei über 75-Jährigen im Vergleich zu jüngeren Altersklassen. Brunt et al. (2016) stellen fest, dass in Wohngebieten mit geringer sozialer Benachteiligung, jedoch hoher Luftverschmutzung, der Anteil an über 75-Jährigen am höchsten ist. Die Exposition gegenüber Luftschadstoffen erhöht die Mortalität sowie potenziell verlorene Lebensjahre durch nicht unfallbedingte Todesfälle, insbesondere bei den über 65-Jährigen im Vergleich zu den unter 65-Jährigen, beobachten Zeng et al. (2017). Ältere Menschen weisen mehr DNA-Schäden auf als jüngere (Santovito et al., 2016; Wong et al., 2018).

4.5.17 Diverse: Krankheiten des Kreislauf- und des Atmungssystems

Einen Zusammenhang zwischen der Exposition gegenüber Feinstaub und einer erhöhten Anzahl an Notfällen aufgrund von Erkrankungen des Herz- und Kreislaufsystems sowie des Atmungssystems zeigen Fung et al. (2005), Phung et al. (2016), Carugno et al. (2016), Powell et al. (2015), Bell et al. (2015), Samoli et al. (2016), Ferreira et al. (2016), Dominici et al. (2006), Bell et al. (2009), Linares et al. (2010), Andersen et al. (2008), Liu et al. (2017) und Liu et al. (2017). Hingegen wurde keine erhöhte Anzahl an Notfällen bei Älteren von Halonen et al. (2016) und Merrifield et al. (2013) berichtet. Eine geringere Anzahl an Notfällen aufgrund von Erkrankungen des Herz- und Kreislauf- und des Atmungssystems bei älteren Menschen im Vergleich zu Jüngeren, sehen Bertoldi et al. (2012).

Ältere Menschen ab 60 Jahren haben ein erhöhtes Mortalitätsrisiko aufgrund von Erkrankungen des Herz- und Kreislaufsystems sowie des Atmungssystems, konstatieren Chan et al. (2011), Yang et al. (2012), Lee et al. (2016), Samoli et al. (2008), Zanobetti et al. (2006), Qiu et al. (2015), Roberts et al. (2006), Zúñiga et al. (2016), Liang et al. (2009), Franklin et al. (2007), Garcia et al. (2016), Chen et al. (2012), Yorifuji et al. (2016), Ostro et al. (2015), Nunes et al. (2013), Klemm et al. (2004), Geng et al. (2013), Samoli et al. (2011), Kollanus et al. (2016), Ma et al. (2011), Analitis et al. (2012), Pinheiro et al. (2014), Yorifuji et al. (2010), Yorifuji et al. (2013), Pun et al. (2017), Wang et al. (2015), Kioumourtzoglou et al. (2016, 2015).

Kein erhöhtes Mortalitätsrisiko bei älteren Personen sehen O'Neill et al. (2008), Fischer et al. (2015), Kashima et al. (2012), Alessandrini et al. (2016), Qian et al. (2007), Jiménez et al. (2010), Zauli Sajani et al. (2011), Wong et al. (2015), Huang et al. (2012), Jimenez et al. (2009), Kim et al.

(2015), Wu et al. 2018, Yang et al. (2013), Ostro et al. (2014), Tsai et al. (2014), Tian et al. (2018), Vichit-Vadakan et al. (2008), Delfino et al. (2009), Fischer et al. (2003), Wu et al. (2018).

Im Zusammenhang mit der Exposition gegenüber Ozon wird eine größere Vulnerabilität bei über 85-jährigen Menschen im Vergleich zu unter 65-Jährigen und insbesondere für Frauen angegeben sowie bei Menschen, die zu Hause starben und an Diabetes litten (Stafoggia et al., 2010). Keinen Unterschied zwischen den Altersklassen unter 65 und über 65 Jahren zeigen Ren et al. (2010) im Hinblick auf die Mortalität unter Ozoneinfluss. Medina-Ramon & Schwartz (2008) stellen bei Personen unter 60 Jahren keinen geschlechtsspezifischen Unterschied im Mortalitätsrisiko fest.

Erhöhte Cadmiumwerte, gemessen im Urin, scheinen mit einer erhöhten Mortalität bei über 60-Jährigen assoziiert zu seien, beobachten Suwazono et al. (2014).

Naess et al. (2007) beobachten, dass Jüngere (51-70 Jahre) vulnerabler im Zusammenhang mit der Exposition gegenüber Luftschadstoffen sind (Stickstoffdioxid und Feinstaub PM10 und PM2.5) und ein höheres Mortalitätsrisiko besitzen, wohingegen Ältere (71-90 Jahre) vulnerabler im Vergleich zur Gesamtbevölkerung sind.

4.5.18 Zusammenfassung

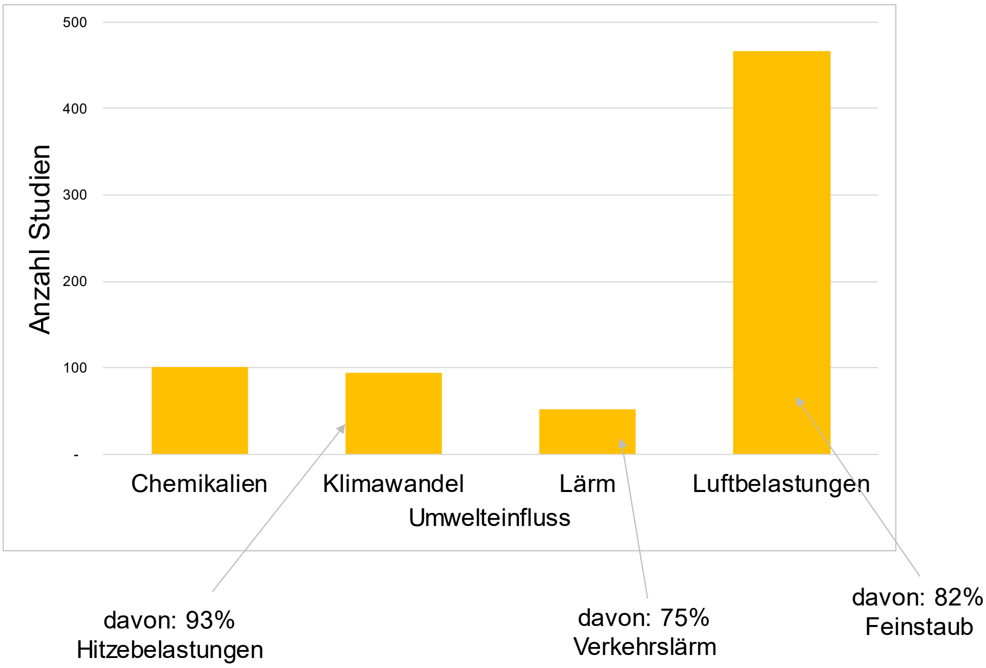
Die für das Themenfeld ***Luftbelastungen*** identifizierten Studien zeigen

- eine besondere Vulnerabilität älterer Menschen gegenüber Feinstaub, die oft zusammen mit Sickstoffdioxid und Ozon untersucht wurden. Das zeigt sich sowohl in einer erhöhten Lungenkrebs-Mortalität/Morbidität als auch in einer erhöhten Anzahl von Notfällen sowie einer erhöhten Mortalität/Morbidität bei Erkrankungen des Herz- und Kreislauf- sowie des Atmungssystems,
- keine klaren Ergebnisse zur Vulnerabilität zu erhöhter Körperkonzentration von Schwermetallen,
- kaum Ergebnisse zur Vulnerabilität Älterer gegenüber Benzol, Bioaerosolen und VOCs.

4.6 Relevanz der Umwelteinflüsse

Die weitaus meisten der identifizierten Studien (466/715, 65,2%) wurden zu Umwelteinflüssen durch ***Luftbelastungen*** durchgeführt, etwa 14 % der identifizierten Studien zu Umwelteinflüssen durch ***Chemikalien*** (101/715, 14,1%) bzw. 13,2 % zu Umwelteinflüssen durch den ***Klimawandel*** (95/715) und nur 53 von 715 Studien (7,4 %) zu Umwelteinflüssen durch ***Lärm*** (Abbildung 15).

Abbildung 15: Anzahl Studien zu den unterschiedlichen Umwelteinflüssen



Quelle: eigene Darstellung BioMath GmbH

Im Bereich ***Chemikalien*** beschäftigt sich ein Übermaß an Studien (auch unter den ausgeschlossenen) mit Arsen, allerdings mit Expositionen in Entwicklungs-/Schwellenländern, die nicht für Mitteleuropa/Deutschland relevant sind. Etwa ein Viertel (25 von 101) der identifizierten Studien im Themenbereich ***Chemikalien*** untersucht die Auswirkungen persistenter organischer Schadstoffe auf unterschiedlichste Krankheiten. Zu den Stoffen Bisphenol A, per- und polyfluorierte Chemikalien, polychlorierte Biphenyle, Schwermetalle sowie Weichmacher/Phthalate wurden jeweils sieben bzw. acht Studien identifiziert. Der Schwerpunkt liegt auf der Untersuchung der Auswirkungen auf die Morbidität (über 80 % der Studien gegenüber 20 % zur Mortalität). Zu den am häufigsten untersuchten Erkrankungen zählen die Ernährungs- und Stoffwechselkrankheiten sowie Erkrankungen des Herz- und Kreislaufsystems.

Im Themenbereich ***Klimawandel*** beschäftigen sich 88 von 95 (93 %) der identifizierten Studienmit den Auswirkungen von Hitzebelastungen (Abbildung 15). Hier liegt der Schwerpunkt auf der Mortalität, insbesondere aufgrund von Erkrankungen des Herz- und Kreislaufsystems. Ein Viertel der Studien untersucht die Auswirkungen auf die Gesundheitsinfrastruktur.

Die im Themenbereich ***Lärm*** identifizierten Studien beschäftigen sich vorrangig mit den Auswirkungen von Verkehrslärm (40 von 53 Studien, 75 %, siehe Abbildung 15). Der Schwerpunkt liegt in der Morbidität (Psychische und Verhaltensstörungen sowie Erkrankungen des Herz- und Kreislaufsystems).

Etwa 65 % aller identifizierten Studien (466 von 716) beschäftigen sich mit dem Thema ***Luftbelastungen***, davon allein 82 % (384 von 466) mit dem Thema Feinstaub (allein oder in Kombination mit Ozon, Stickstoffoxiden, Kohlenstoffoxiden, Hitzebelastungen o.a., Abbildung 15). Der Schwerpunkt liegt hier in der Morbidität bzw. Mortalität aufgrund von Erkrankungen des Herz- und Kreislaufsystems.

Eine Einschätzung der Relevanz der Umwelteinflüsse anhand der Anzahl identifizierter Studien stellt die Luftbelastung durch Feinstaub (allein oder in Kombination mit Ozon, Stickstoffoxiden, Kohlenstoffoxiden, Hitzebelastungen o.a.) deutlich an oberster Stelle. Auch im Hinblick auf die Einflüsse auf die Gesundheitsinfrastruktur wurden die meisten Studien für das Themenfeld Luftbelastungen, insbesondere durch Feinstaub identifiziert.

4.7 Unterschiede innerhalb der Gruppe der älteren Menschen

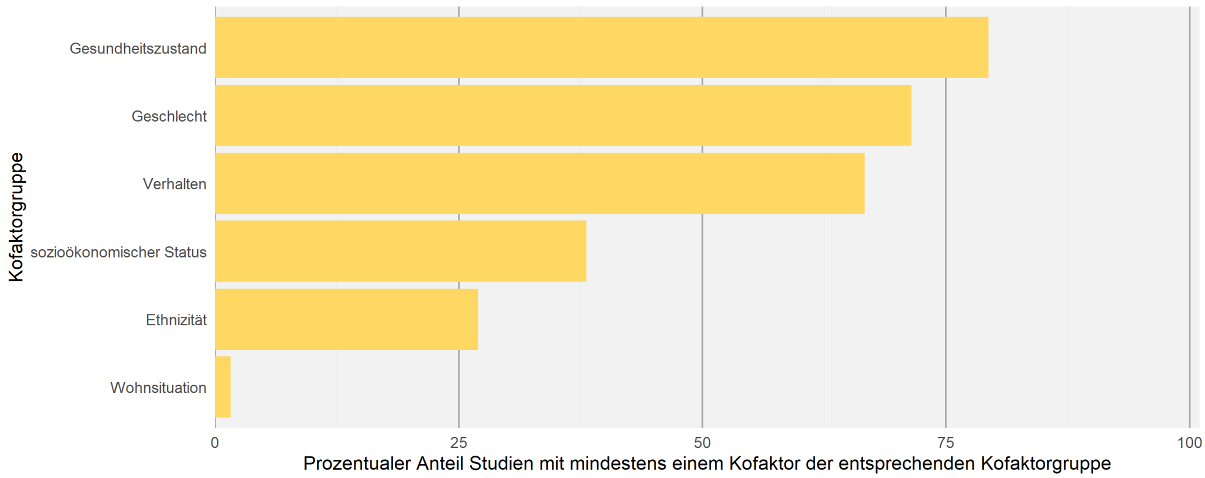
Die Studien untersuchen auch den Einfluss von Kofaktoren auf die Vulnerabilität. Je nach Umweltexposition können dabei die Schwerpunkte an Kofaktoren divers vorliegen. Das Geschlecht als Kofaktor wird in nahezu allen Studien separat nach Frauen und Männern betrachtet (ausgenommen in den Studien, in denen nur ein Geschlecht untersucht wurde). Alle anderen Kofaktoren unterscheiden sich von Studie zu Studie, auch in Abhängigkeit von konkret untersuchter Exposition und Erkrankung.

4.7.1 Kofaktoren, die in den Studien zu Umwelteinflüssen durch Chemikalien untersucht werden

In die Studien zu Umwelteinflüssen durch **Chemikalien** werden die folgenden Kofaktoren einbezogen:

- Geschlecht,
- Gesundheitszustand (Blutwerte, BMI, Fettmasse, Gesundheitsstatus, Gewicht, Größe, Hüftumfang, Komorbidität, Diabetes, Familienanamnese, Medikamente, Menopause, Schwangerschaft, Urinwerte, Vitalparameter, Schlaf, Amalgam Füllungen),
- Verhalten (Alkoholkonsum, Rauchgewohnheiten, körperliche Aktivität, Ernährung, Fischkonsum, Schnupftabak-Konsum, Shisha-Konsum, Wasserkonsum),
- sozioökonomischer Status (ausgeübter Beruf, Bildung, Einkommen, Familienstand, Krankenversicherung, Wohnumfeld, Armut),
- Ethnizität,
- Wohnsituation.

Abbildung 16: Häufigkeit der untersuchten Kofaktoren zum Einfluss durch Chemikalien



Quelle: eigene Darstellung BioMath GmbH

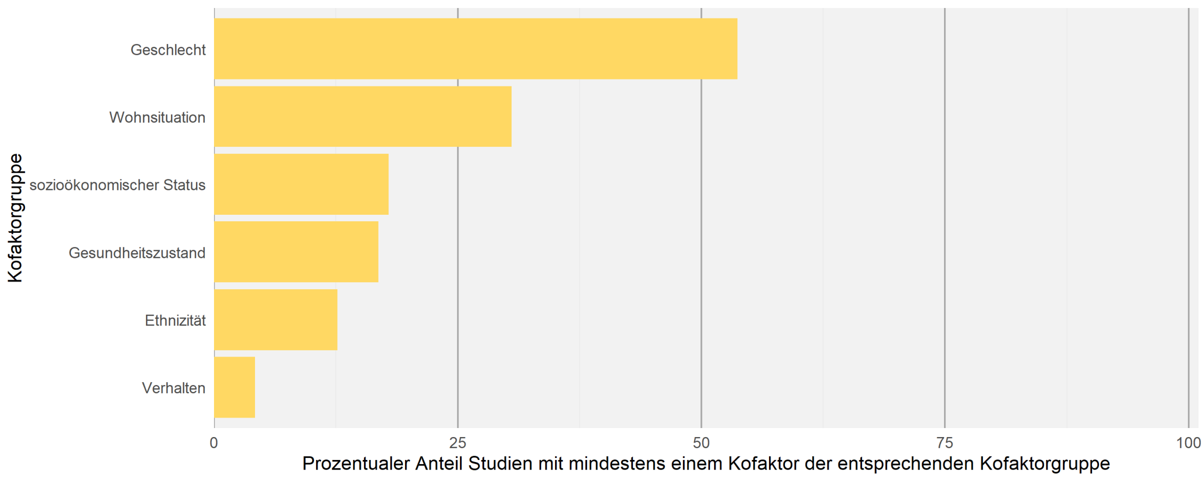
In den Studien im Themenfeld Chemie werden neben Unterschieden zwischen den Geschlechtern vor allem der Ko-Einfluss des Gesundheitszustandes (BMI, Körpergewicht, Fettmasse) und des Verhaltens (Ernährung, Tabak- und Nikotinkonsum) untersucht (Abbildung 16).

4.7.2 Kofaktoren, die in den Studien zu Umwelteinflüssen durch Klimawandel untersucht werden

In die Studien zu Umwelteinflüssen durch ***Klimawandel*** werden die folgenden Kofaktoren einbezogen:

- Geschlecht,
- Wohnsituation (Obdachlosigkeit, Art Wohnung, Ausstattung Wohnung, Nachbarschaft),
- Gesundheitszustand (Gesundheitszustand, Komorbidität, Medikamente, BMI, Vitalparameter),
- sozioökonomischer Status (ausgeübter Beruf, Bildung, Einkommen, Haushaltslage, Familienstand),
- Verhalten (Alkoholkonsum, Rauchgewohnheiten, körperliche Aktivität),
- Ethnizität.

Abbildung 17: Häufigkeit der untersuchten Kofaktoren zum Einfluss durch Klimawandel



Quelle: eigene Darstellung BioMath GmbH

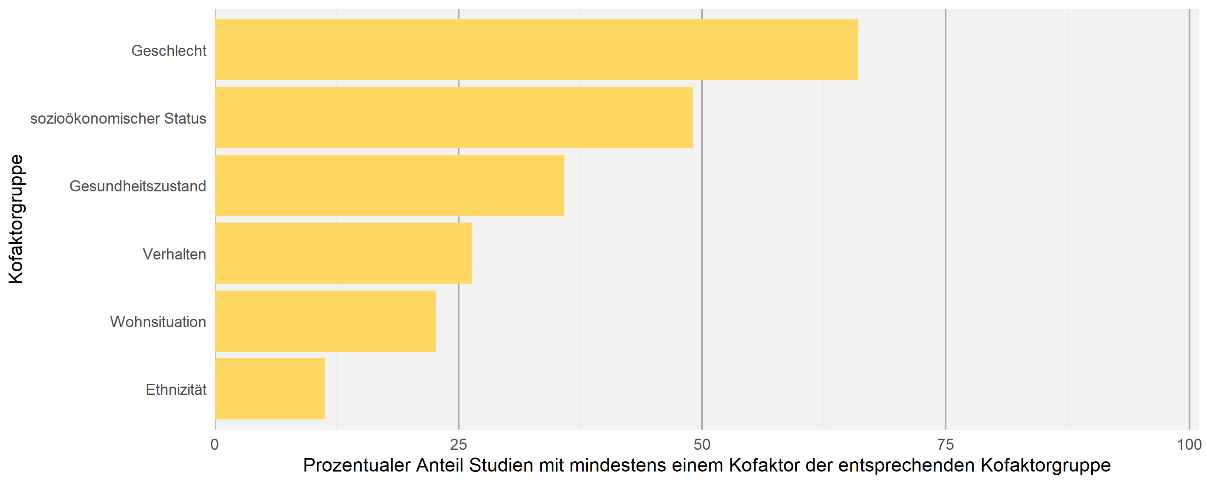
In den Studien im Themenfeld Klimawandel werden Unterschiede zwischen den Geschlechtern vor allem der Ko-Einfluss der Wohnsituation und des sozioökonomischen Status (Ethnizität, Bildung, Familienstand, Einkommen) untersucht (Abbildung 17).

4.7.3 Kofaktoren, die in den Studien zu Umwelteinflüssen durch Lärm untersucht werden

In die Studien zu Umwelteinflüssen durch ***Lärm*** werden die folgenden Kofaktoren einbezogen:

- Geschlecht,
- Wohnsituation (Wohnzeit, Art Wohnung, Hauseigenschaften, Anzahl Mitbewohnende, Art Fenster, Lage des Schlafzimmers, Nachbarschaft, Wohneigentum, Wohndichte, lokale Kriminalität),
- sozioökonomischer Status (ausgeübter Beruf, Bildung, Einkommen, Haushaltslage, Familienstand, Anzahl Kinder),
- Verhalten (Alkoholkonsum, Rauchgewohnheiten, körperliche Aktivität, Ernährung, Kaffeekonsum, Hormoneinnahme),
- Gesundheitszustand (BMI, Familienanamnese, Gesundheitszustand, Komorbidität, Hüftumfang, Medikamente, Vitalparameter),
- Ethnizität (auffällige Minderheiten, Ethnie, Herkunftsland).

Abbildung 18: Häufigkeit der untersuchten Kofaktoren zum Einfluss durch Lärm



Quelle: eigene Darstellung BioMath GmbH

In den Studien im Themenfeld Lärm werden neben Unterschieden zwischen den Geschlechtern vor allem der Ko-Einfluss des sozioökonomischen Status (Bildung, ausgeübter Beruf) untersucht (Abbildung 18).

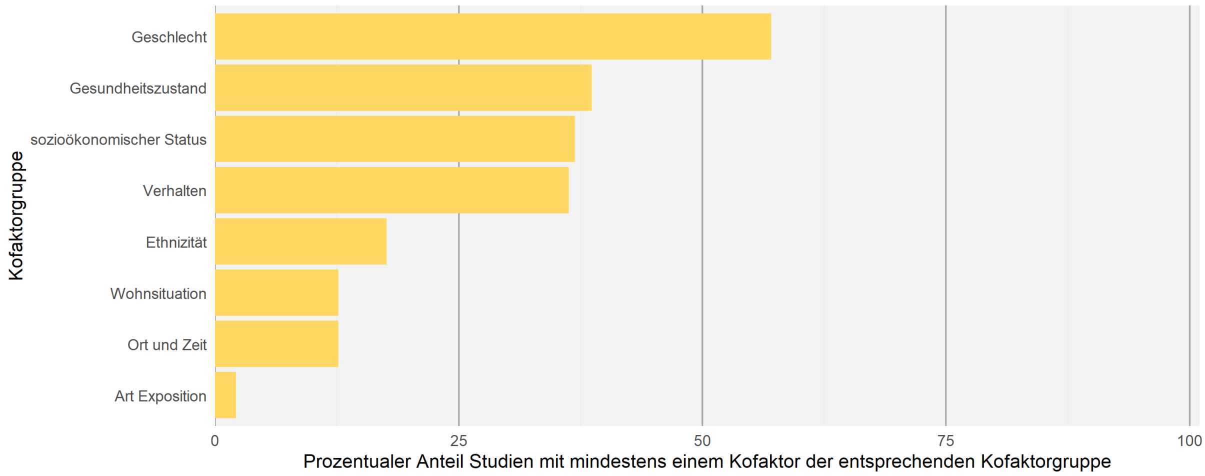
4.7.4 Kofaktoren, die in den Studien zu Umwelteinflüssen durch Luftbelastungen untersucht werden

In den Studien zu Umwelteinflüssen durch ***Luftbelastungen*** werden die folgenden Kofaktoren untersucht:

- Geschlecht,
- Gesundheitszustand (BMI, Komorbidität, Medikamente, Familienanamnese, Blutwerte, Vitalparameter),

- sozioökonomischer Status (Bildung, Einkommen, Familienstand, ausgeübter Beruf, Urbanizität, Wohnumfeld),
- Verhalten (Rauchgewohnheiten, Alkoholkonsum, körperliche Aktivität, Ernährung),
- Ethnizität,
- Wohnsituation (Wohnort).,
- Ort und Zeit,
- Art der Exposition.

Abbildung 19: Häufigkeit der untersuchten Kofaktoren zum Einfluss durch Luftbelastungen



Quelle: eigene Darstellung BioMath GmbH

In den Studien im Themenfeld Luftbelastungen werden neben Unterschieden zwischen den Geschlechtern vor allem der Ko-Einfluss des Gesundheits- und des sozioökonomischen Status untersucht (Abbildung 19).

5 Diskussion

Die identifizierten Studien weisen eine starke Heterogenität im Hinblick auf die untersuchten Expositionen und Outcomes auf. Diese Heterogenität zeigt sich in der Vielfalt der Stichprobenahme und Eigenschaften der Populationen (beispielhaft in Tabelle 27 dargestellt) sowie der Art der Messung der Exposition und der beschriebenen Morbidität (ICD 10 Klassen, einzelne Krankheiten). Auch wenn über alle Umwelteinflüsse hinweg ein deutlicher Schwerpunkt auf den Auswirkungen auf das Herz- und Kreislaufsystem sowie das Atmungssystem liegt, sind die konkret spezifizierten Erkrankungen sehr vielfältig (beispielhaft in Tabelle 28 dargestellt). Auch die analysierten Expositionen weisen eine hohe Bandbreite auf (beispielhaft in Tabelle 28 dargestellt). Weiterhin spiegeln die Studienmerkmale und die einbezogenen Kofaktoren unterschiedlichste Bedingungen, unter denen die Studien durchgeführt wurden, wider.

Tabelle 27: Inhomogenität der Populationen von 12 Studien zu Auswirkungen von Lärm auf Herz- und Kreislauferkrankungen

Studie			Population		
AutorInnen	**Jahr**	**Stichprobenziehung**	**Datenerhebung**	**Alter**	**Umfang**
Andrew et al.	2013	Versicherung, alle Versicherten	Arztabrech-nungen	nur >65	6.027.363
Azuma et al.	2017	Stichprobe, willkürlich	Webumfrage	nur >65	6.181
Banerjee et al.	2014	Stichprobe, bewusste Auswahl	Interview	<60, ≥60	909
Bodin et al.	2009	Stichprobe, bewusste Auswahl	Fragebogen	18-39, 40-59, 60-80	27.963
Bodin et al.	2016	Stichprobe, bewusste Auswahl	Fragebogen	≤39, 40-50, 50-59, 60-69, 70-79, ≥80	9.031
Fuks et al.	2011	Studie, alle Teilnehmer	Untersuchung	<60, ≥60	4.814
Girard et al.	2014	Register, alle Erfassten	Datenüber-nahme	nur >65	644
Hart et al.	2014	Studie, alle Teilnehmer	Fragebogen	∅ 64,3	107.130
Jarup et al.	2008	Stichprobe, bewusste Auswahl	Untersuchung	45-70, Untergruppe ≥65	4.861
Niemann et al.	2006	Stichprobe, bewusste Auswahl	Interview	<60, ≥60	8.539
Poulsen et al.	2018	Verschnitt 3 Register	Datenüber-nahme	<40, 40-50, 50-60, ≥60	535.675

Studie			**Population**		
Rhee et al.	2008	Stichprobe, bewusste Auswahl	Fragebogen	<40, 40-49, 50-59, 60-69, ≥70	951
Roswall et al.	2015	Studie, alle Teilnehmer	Datenüber-nahme	50–64	1.759

Tabelle 28: Inhomogenität der Expositionen und Outcomes von 12 Studien zu Auswirkungen von Lärm auf Herz- und Kreislauferkrankungen

Studie		**Exposition**		**Outcome**	
AutorInnen	**Jahr**	**Art**	**Messung**	**Art**	**Feststellung**
Andrew et al.	2013	Flugzeuge	Lärmkontur Gruppe	Herzversagen, Herz-Rhythmusstörungen, zerebovaskuläre Ereignisse, ischämische Herzkrankheit, periphere Gefäßerkrankungen	Arztdiagnose
Azuma et al.	2017	Umwelt	Selbst-einschätzung	Symptome: Brustschmerzen, Pulsunregelmäßigkeiten, Sprechschwierigkeiten, Lähmungen Gliedmaßen, Fußschmerzen, Taubheit	Selbstein-schätzung
Banerjee et al.	2014	Stadt-verkehr	Modellierung, Kategorisierung	Bluthochdruck	eigene Angaben zur Arztdiagnose
Bodin et al.	2009	Straßen-verkehr	Modellierung, Kategorisierung	Bluthochdruck	Selbstein-schätzung
Bodin et al.	2016	Straßen-verkehr	Modellierung, Kategorisierung	Herzinfarkt, ischämische Herzkrankheit	Registereintrag
Fuks et al.	2011	Verkehr	Modellierung, Kategorisierung	Bluthochdruck	Untersuchung
Girard et al.	2014	Industrie	Selbst-einschätzung	Tod an kardiovaskulären Erkrankungen	Untersuchung
Hart et al.	2014	Verkehr	Berechnung Entfernung zur Straße	plötzlicher Herztod, Herzinfarkt	Patientenakte
Jarup et al.	2008	Flugzeuge, Straßen-verkehr	Modellierung, Kategorisierung	Bluthochdruck	Untersuchung
Niemann et al.	2006	Verkehr, Nachba-rschaft	Selbstein-schätzung	kardiovaskuläre Symptome, Bluthochdruck	Selbstein-schätzung

Studie		**Exposition**		**Outcome**	
Poulsen et al.	2018	Windkraft-räder	Modellierung, Kategorisierung	Verschreibung Medikamente gegen Bluthochdruck	Registereintrag
Rhee et al.	2008	Militär-flugzeuge	Messung (Zeitraum?)	Bluthochdruck	Untersuchung
Roswall et al.	2015	Stadt-verkehr	Modellierung	Mortalität	Studiendaten

Obwohl Beobachtungsstudien im Vergleich zu Interventionsstudien schwächer im Nachweis von Dosis-Wirkungsbeziehungen sind, liegen ihre Vorteile in ihrer Machbarkeit, Ethik und Kosten sowie in der Reflektion realistischer Expositionsszenarien. In umweltepidemiologischen Studien werden unter Anwendung verschiedener Studiendesigns Umwelteinflüsse beobachtet und gemessen. Personen können in der Regel nicht, wie in beispielsweise kontrollierten randomisierten Experimenten, gezielt bestimmten Werten ausgesetzt werden. Damit werden die Probandinnen und Probanden in ihrer realen Umgebung beforscht, jedoch erschwert es die Erfassung der Exposition sowie möglicher Störgrößen. Ein direkter Vergleich von Studien mit unterschiedlichen Studiendesigns und Expositionserhebungen ist nicht ohne weiteres möglich.

Bei den identifizierten Studien ist die Exposition oftmals geschätzt oder berechnet auf Basis von Richtwerten/Einzeldaten, insbesondere in den Bereichen ***Klimawandel*** (Exposition auf Basis aufgezeichneter Wetterdaten), ***Lärm*** (Exposition auf Basis von Richtwerten oder Kennzahlen) und ***Luftbelastungen*** (Exposition auf Basis aufgezeichneter Messungen).

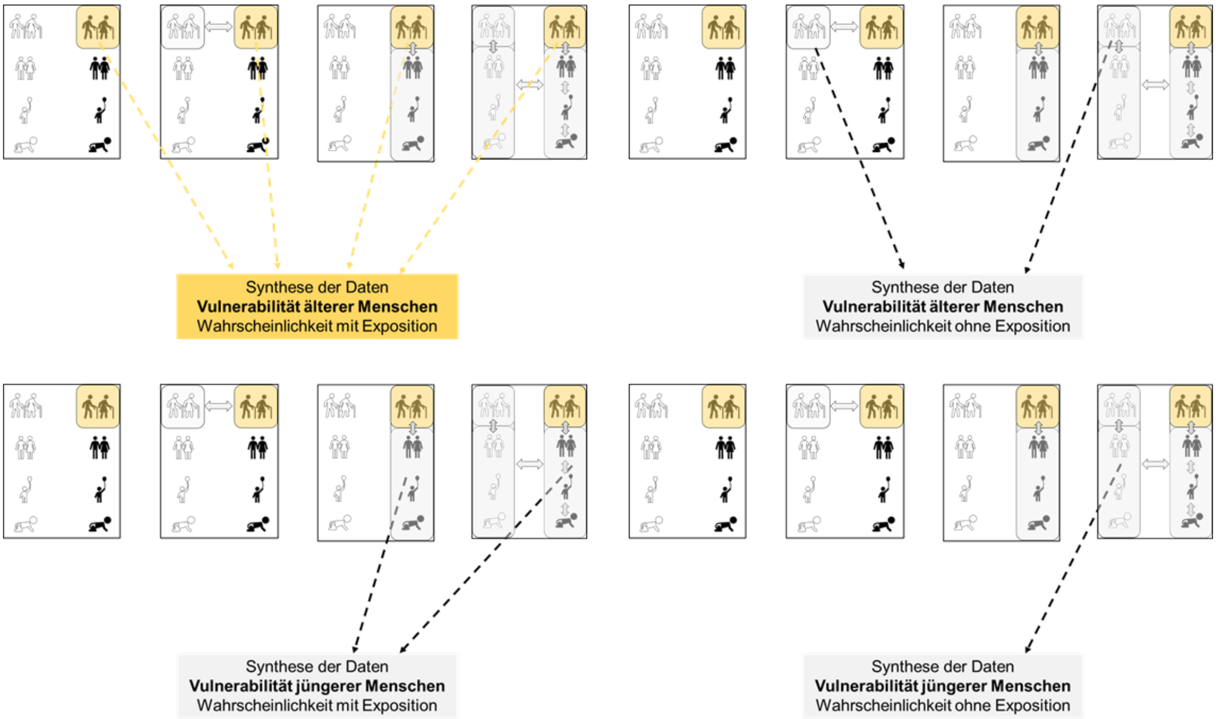
Diverse identifizierte Publikationen basieren auf der gleichen Studie (z. B. WHO LARES Studie, National Health and Nutrition Examination Survey NHANES, PIVUS Studie Schweden, climate and health impact national assessment study CHINAs China, Heinz Nixdorf Recall Studie Deutschland) bzw. den gleichen aufgezeichneten Expositionsdaten (Wetterdienst, Lärm-, Luftaufzeichnungen), was in der Erforschung der Umwelteinflüsse unumgänglich ist. Bei der Bewertung der Ergebnisse muss deshalb auf einen Publikations-Bias geachtet werden.

Für die Qualitätsbewertung epidemiologischer Studien sind verschiedene Instrumente veröffentlicht, sowohl für die Bewertung der Berichterstattung („reporting assessment tools“) als auch für die Bewertung eines Bias („critical appraisal tools“, „risk of bias tools“). In drei Reviews (Sanderson et al., 2007; Wang et al., submitted 2019 und Shamliyan et al., 2010) identifizierten die AutorInnen über 100 Instrumente. Im Gegensatz zur Bewertung randomisierter kontrollierter Studien, in denen sich Standards wie GRADE (Schünemann et al., 2013) durchgesetzt haben, existiert derzeit kein Konsensus zu optimalen Tools oder Schlüsselkriterien für die Bewertung epidemiologischer Studien bzw. Beobachtungsstudien. Die Applikation von GRADE mit dem Ansatz der initialen Einstufung der Qualität von Beobachtungsstudien als ‚niedrig‘ ist für eine vergleichende Bewertung ausschließlich von Beobachtungsstudien zu wenig differenziert und daher nicht geeignet. Verschiedene Organisationen (u.a. EFSA, BfR) arbeiten an der Entwicklung und Etablierung von Richtlinien, da sie Beobachtungsstudien als wertvolle Beweisquelle für die Identifizierung und Charakterisierung von gesundheitsgefährdenden Stoffen ansehen. Für Reviews epidemiologischer Studien wird weitverbreitet der OHAT Ansatz (Office of Health Assessment and Translation (OHAT) 2019) genutzt, der die grundlegende Herangehensweise von GRADE (Initialeinstufung und Herab- bzw. Heraufstufen nach Bias bzw. Effektbewertung) verfolgt.

Eine umfassende Qualitätsbewertung der insgesamt etwa 700 einbezogenen Publikationen war im Rahmen und innerhalb der Laufzeit dieses Projektes nicht realisierbar, da. Instrumente zur Qualitätsbewertung von Beobachtungsstudien, wie z.B. STROBE zur Bewertung der Berichterstattung (Elm et al., 2008) oder ROBINS-E[5] zur Bias-Bewertung etwa 20 bzw. 50 einzeln zu bewertende Kriterien umfassen. Zur Qualitätsbewertung der Studien wurde deshalb eine einfache Skala angewandt, die auf dem OHAT Ansatz beruht.

Die Synthese der Studienergebnisse konnte aufgrund von der großen Heterogenität der Studien nur qualitativ erfolgen. Eine quantitative Synthese wäre nur für Studien innerhalb der gleichen Exposition – Outcome Kombination möglich, unter gleichen Studienbedingungen und unter Berücksichtigung gleicher Kofaktoren. Eine Analyse der Gründe widersprüchlicher Ergebnisse in den identifizierten Studien und eine Zusammenfassung in einer Meta-Analyse war im Rahmen dieses Projektes nicht möglich. Auf Basis der extrahierten Daten könnte jedoch eine Prüfung der möglichen Synthese von Studienergebnissen erfolgen wie in Abbildung 20 und Abbildung 21 dargestellt.

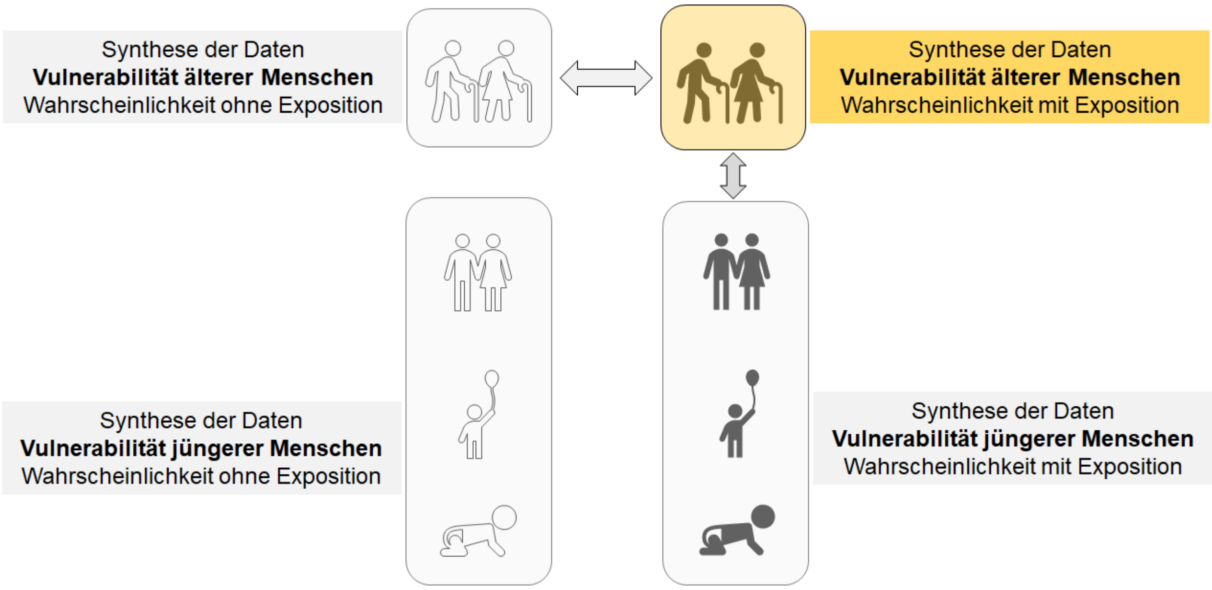
Abbildung 20: Mögliche Synthese der Ergebnisdaten aus den unterschiedlichen Studiendesigns



Quelle: eigene Darstellung BioMath GmbH

[5] https://www.bristol.ac.uk/population-health-sciences/centres/cresyda/barr/riskofbias/robins-e/

Abbildung 21: Möglicher übergreifender Vergleich der Ergebnisdaten



Quelle: eigene Darstellung BioMath GmbH

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A Anhang Suchstrategie

A.1 Suchbegriffe

Tabelle 29: Suchbegriffe und grundsätzliche Struktur der Suchgleichung (für elektronische Datenbanken)

Set	Feld	Suchbegriffe/-gleichung	MeSH Terms	Konzept/Schlüsselelemente
#1	Topic	(((human OR adult* OR men OR women OR people OR person* OR population * OR patient* OR citizen* OR resident*) AND ((elder* OR old* OR age*) AND ((60 NEAR/0 year*) OR (65 NEAR/0 year*) OR (70 NEAR/0 year*) OR (75 NEAR/0 year*) OR (80 NEAR/0 year*)))) OR (senior* OR pensioner* OR retire*))	“Aged"[Mesh][1]	Population: ältere Menschen
#2	Topic	(air* OR aer*) AND pollut*	“Air Pollution"[Mesh][2]	Exposition: Luftbelastung generell
#3	Topic	((particle* OR particulate*) NEAR/0 (fine OR matter)) OR PM2.5 OR PM10*	“Particulate Matter"[Mesh][3]	Exposition: Luftbelastung Feinstaub
#4	Topic	(nitrogen NEAR/0 *oxide*) OR NO_2	“Nitrogene Dioxide"[Mesh][4]	Exposition: Luftbelastung Stickstoffdioxid
#5	Topic	ozone	“Ozone"[Mesh][5]	Exposition: Luftbelastung Ozon
#6	Topic	(heavy NEAR/0 metal*) AND (lead OR Pb OR cadmium OR Cd)	“Cadmium"[Mesh][6] “Lead”[MeSH][7]	Exposition: Luftbelastung/Chemikalien Schwermetalle Cadmium, Blei
#7	Topic	(*volatile NEAR/0 organic NEAR/0 compound*) OR VOC OR VVOC OR SVOC OR *aldehyde* OR terpene*	“Volatile Organic Compounds"[Mesh][8]	Exposition: Luftbelastung flüchtige organische Verbindungen
#8	Topic	benzene	“Benzene"[Mesh][9]	Exposition: Luftbelastung Benzol
#9	Topic	(bio* NEAR/0 aerosol*) OR mould OR fung* OR mycotoxin* OR endotoxin*	“Inhalation exposure"[Mesh][10]	Exposition: Luftbelastung Bioaerosole
#10	Topic	“climate change" OR "global warming"	“Climate Change"[Mesh][11]	Exposition: Klimawandel generell
#11	Topic	(extreme OR wave* OR tropical) NEAR/1 (weather OR		Exposition: Klimawandel Hitze

Set	Feld	Suchbegriffe/-gleichung	MeSH Terms	Konzept/Schlüsselelemente
		heat OR temperature* OR night*) OR "urban heat island"		
#12	Topic	storm* OR (heavy NEAR/2 (rain* OR precipitation))		Exposition: Klimawandel Sturm, Starkregen
#13	Topic	flood* OR (storm NEAR/0 water)		Exposition. Hochwasser, Überflutung
#14	Topic	(environment* OR traffic OR transport* OR rail* OR (air NEAR/0 craft) OR road OR recreation* OR leisure OR neighbor* OR industr* OR construction*) NEAR/1 noise	"Noise"[Mesh][12]	Exposition: Lärm
#15	Topic	((low NEAR/0 frequen*) OR infrasound) NEAR/2 (living OR environment* OR noise)		Exposition: Lärm Infraschall
#16	Topic	arsenic	"Arsenic"[Mesh][13]	Exposition: Chemikalien Arsen
#17	Topic	PCB OR (polychlorinated NEAR/0 biphenyl*) OR (*chlorine NEAR/0 compound*)	"Polychlorinated Biphenyls"[Mesh][14]	Exposition: Chemikalien PCBs
#18	Topic	PFC OR PFAS OR PFOA OR (*flurinated NEAR/0 (chemical* OR alkyl))	"Fluorocarbons"[Mesh][15]	Exposition: Chemikalien PFCs
#19	Topic	phthalate* OR plasticizer*	"Plastizisers"[Mesh][16]	Exposition: Chemikalien Phthalate
#20	Topic	(bisphenol NEAR/0 A) OR BPA	bisphenol A [Supplementary concept]	Exposition: Chemikalien Bisphenol A
#21	Topic	health* OR mortality OR morbidity OR disease*	"Health"[Mesh][17] "Mortality"[Mesh][18] "Morbidity"[Mesh][19] "Disease"[Mesh][20]	Outcome: Gesundheit
#22	Topic	(((emergenc* OR hospital*) NEAR/2 (number* OR count OR quantity OR admission*)) OR hospitali?ation*)	"Emergencies"[Mesh][21] "Hospitalisation"[Mesh][22]	Outcome: Gesundheits-infrastruktur
#23	Year pub-lished	PUBLICATION YEARS: (2004 – 2018)		Einschlusskriterium: Datum der Veröffentlichung
#24	Langu-age	LANGUAGE: (English OR German)		Einschlusskriterium: Sprache der Veröffentlichung
#25	Doc Type	DOCUMENT TYPES: (ARTICLE)		Einschlusskriterium: Format der Veröffentlichung

[1] A person older than 65 years of age.
[2] The presence of contaminants or pollutant substances in the air (AIR POLLUTANTS) that interfere with human health or welfare, or produce other harmful environmental effects. The substances may include GASES; PARTICULATE MATTER; or volatile ORGANIC CHEMICALS.
[3] Particles of any solid substance, generally under 30 microns in size, often noted as PM30. There is special concern with PM1 which can get down to PULMONARY ALVEOLI and induce MACROPHAGE ACTIVATION and PHAGOCYTOSIS leading to FOREIGN BODY REACTION and LUNG DISEASES.
[4] Nitrogen oxide (NO_2). A highly poisonous gas. Exposure produces inflammation of lungs that may only cause slight pain or pass unnoticed, but resulting edema several days later may cause death. (From Merck, 11th ed) It is a major atmospheric pollutant that is able to absorb UV light that does not reach the earth's surface.
[5] The unstable triatomic form of oxygen, O3. It is a powerful oxidant that is produced for various chemical and industrial uses. Its production is also catalyzed in the ATMOSPHERE by ULTRAVIOLET RAY irradiation of oxygen or other ozone precursors such as VOLATILE ORGANIC COMPOUNDS and NITROGEN OXIDES. About 90 % of the ozone in the atmosphere exists in the stratosphere (STRATOSPHERIC OZONE).
[6] An element with atomic symbol Cd, atomic number 48, and atomic weight 112.41. It is a metal and ingestion will lead to CADMIUM POISONING.
[7] A soft, grayish metal with poisonous salts; atomic number 82, atomic weight 207.2, symbol Pb.
[8] Organic compounds that have a relatively high VAPOR PRESSURE at room temperature.
[9] Toxic, volatile, flammable liquid hydrocarbon byproduct of coal distillation. It is used as an industrial solvent in paints, varnishes, lacquer thinners, gasoline, etc. Benzene causes central nervous system damage acutely and bone marrow damage chronically and is carcinogenic. It was formerly used as parasiticide.
[10] The exposure to potentially harmful chemical, physical, or biological agents by inhaling them.
[11] Any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). It may result from natural factors such as changes in the sun's intensity, natural processes within the climate system such as changes in ocean circulation, or human activities.
[12] Any sound which is unwanted or interferes with HEARING other sounds.
[13] A shiny gray element with atomic symbol As, atomic number 33, and atomic weight 75. It occurs throughout the universe, mostly in the form of metallic arsenides. Most forms are toxic. According to the Fourth Annual Report on Carcinogens (NTP 85-002, 1985), arsenic and certain arsenic compounds have been listed as known carcinogens.
[14] Industrial products consisting of a mixture of chlorinated biphenyl congeners and isomers. These compounds are highly lipophilic and tend to accumulate in fat stores of animals. Many of these compounds are considered toxic and potential environmental pollutants.
[15] Liquid perfluorinated carbon compounds which may or may not contain a hetero atom such as nitrogen, oxygen or sulfur, but do not contain another halogen or hydrogen atom. This concept includes fluorocarbon emulsions and fluorocarbon blood substitutes.
[16] A plasticizer used in most plastics and found in water, air, soil, plants and animals. It may have some adverse effects with long-term exposure.
[17] The state of the organism when it functions optimally without evidence of disease.
[18] All deaths reported in a given population.
[19] The proportion of patients with a particular disease during a given year per given unit of population.
[20] A definite pathologic process with a characteristic set of signs and symptoms. It may affect the whole body or any of its parts, and its etiology, pathology, and prognosis may be known or unknown.
[21] Situations or conditions requiring immediate intervention to avoid serious adverse results.
[22] The confinement of a patient in a hospital.

A.2 Suche und Suchergebnisse

Tabelle 30: Web of Science Suche am 14.11.2018

Set	Search String	Anzahl Treffer
#1	(TS=(((human OR adult* OR men OR women OR people OR person* OR population * OR patient* OR citizen* OR resident*) AND ((elder* OR old* OR age*) AND ((60 NEAR/0	823

Set	Search String	Anzahl Treffer
	year*) OR (65 NEAR/0 year*) OR (70 NEAR/0 year*) OR (75 NEAR/0 year*) OR (80 NEAR/0 year*)))) OR (senior* OR pensioner* OR retire*))) AND (TS=((air* OR aer*) AND pollut*) OR TS=(((particle* OR particulate*) NEAR/0 (fine OR matter)) OR PM2.5 OR PM10) OR TS=((nitrogen NEAR/0 *oxide*) OR NO2) OR TS=(ozone) OR TS=((heavy NEAR/0 metal*) AND (lead OR Pb OR cadmium OR Cd)) OR TS=((*volatile NEAR/0 organic NEAR/0 compound*) OR VOROC OR VVOC OR SVOC OR *aldehyde* OR terpene*) OR TS=(benzene) OR TS=((bio* NEAR/0 aerosol*) OR mould OR mycotoxin* OR endotoxin*)) AND (TS=(health* OR mortality OR morbidity OR disease*) OR TS=(((emergenc* OR hospital*) NEAR/2 (number* OR count OR quantity OR admission*)) OR hospitali?ation*)) AND (PY=(2004-2018)) AND (DT=(ARTICLE)) AND (LA=(ENGLISH OR GERMAN)) *Databases= WOS, BCI, CCC, DRCI, KJD, MEDLINE, RSCI, SCIELO, ZOOREC*	
#2	(TS=(((human OR adult* OR men OR women OR people OR person* OR population * OR patient* OR citizen* OR resident*) AND ((elder* OR old* OR age*) AND ((60 NEAR/0 year*) OR (65 NEAR/0 year*) OR (70 NEAR/0 year*) OR (75 NEAR/0 year*) OR (80 NEAR/0 year*)))) OR (senior* OR pensioner* OR retire*))) AND (TS=(“climate change" OR "global warming") OR TS=((extreme OR wave* OR tropical) NEAR/1 (weather OR heat OR temperature* OR night*) OR "urban heat island") OR TS=(storm* OR (heavy NEAR/2 (rain* OR precipitation))) OR TS=(flood* OR (storm NEAR/0 water))) AND (TS=(health* OR mortality OR morbidity OR disease*) OR TS=(((emergenc* OR hospital*) NEAR/2 (number* OR count OR quantity OR admission*)) OR hospitali?ation*)) AND (PY=(2004-2018)) AND (DT=(ARTICLE)) AND (LA=(ENGLISH OR GERMAN)) *Databases= WOS, BCI, CCC, DRCI, KJD, MEDLINE, RSCI, SCIELO, ZOOREC*	320
#3	(TS=(((human OR adult* OR men OR women OR people OR person* OR population * OR patient* OR citizen* OR resident*) AND ((elder* OR old* OR age*) AND ((60 NEAR/0 year*) OR (65 NEAR/0 year*) OR (70 NEAR/0 year*) OR (75 NEAR/0 year*) OR (80 NEAR/0 year*)))) OR (senior* OR pensioner* OR retire*))) AND (TS=((rail* OR environment* OR traffic OR transport* OR (air NEAR/0 craft) OR road OR recreation* OR leisure OR neighbor* OR industr* OR construction*) NEAR/1 noise) OR TS=(((low NEAR/0 frequen*) OR infrasound) NEAR/2 (living OR environment* OR noise))) AND (TS=(health* OR mortality OR morbidity OR disease*) OR TS=(((emergenc* OR hospital*) NEAR/2 (number* OR count OR quantity OR admission*)) OR hospitali?ation*)) AND (PY=(2004-2018)) AND (DT=(ARTICLE)) AND (LA=(ENGLISH OR GERMAN)) *Databases= WOS, BCI, CCC, DRCI, KJD, MEDLINE, RSCI, SCIELO, ZOOREC*	45
#4	(TS=(((human OR adult* OR men OR women OR people OR person* OR population * OR patient* OR citizen* OR resident*) AND ((elder* OR old* OR age*) AND ((60 NEAR/0 year*) OR (65 NEAR/0 year*) OR (70 NEAR/0 year*) OR (75 NEAR/0 year*) OR (80 NEAR/0 year*)))) OR (senior* OR pensioner* OR retire*))) AND (TS=(arsenic) OR TS=(PCB OR (polychlorinated NEAR/0 biphenyl*) OR (*chlorine NEAR/0 compound*)) OR TS=(PFC OR PFAS OR PFOA OR (*flurinated NEAR/0 (chemical* OR alkyl))) OR TS=(phthalate* OR plasticizer*) OR TS=((bisphenol NEAR/0 A) OR BPA)) AND (TS=(health* OR mortality OR morbidity OR disease*) OR TS=(((emergenc* OR hospital*) NEAR/2 (number* OR count OR quantity OR admission*)) OR hospitali?ation*)) AND (PY=(2004-2018)) AND (DT=(ARTICLE)) AND (LA=(ENGLISH OR GERMAN)) *Databases= WOS, BCI, CCC, DRCI, KJD, MEDLINE, RSCI, SCIELO, ZOOREC*	189

Tabelle 31: Scopus Suche am 14.11.2018

Set	Search String	Anzahl Treffer
#1	(TITLE-ABS-KEY(((human OR adult* OR men OR women OR people OR person* OR population * OR patient* OR citizen* OR resident*) AND ((elder* OR old* OR age*) AND ((60 W/0 year*) OR (65 W/0 year*) OR (70 W/0 year*) OR (75 W/0 year*) OR (80 W/0 year*)))) OR (senior* OR pensioner* OR retire*))) AND (TITLE-ABS-KEY((air* OR aer*) AND pollut*) OR TITLE-ABS-KEY(((particle* OR particulate*) W/0 (fine OR matter)) OR PM2.5 OR PM10) OR TITLE-ABS-KEY((nitrogen W/0 *oxide*) OR NO2) OR TITLE-ABS-KEY(ozone) OR TITLE-ABS-KEY((heavy W/0 metal*) AND (lead OR Pb OR cadmium OR Cd)) OR TITLE-ABS-KEY((*volatile W/0 organic W/0 compound*) OR VOROC OR VVOC OR SVOC OR *aldehyde* OR terpene*) OR TITLE-ABS-KEY(benzene) OR TITLE-ABS-KEY((bio* W/0 aerosol*) OR mould OR mycotoxin* OR endotoxin*)) AND (TITLE-ABS-KEY(health* OR mortality OR morbidity OR disease*) OR TITLE-ABS-KEY(((emergenc* OR hospital*) W/2 (number* OR count OR quantity OR admission*)) OR hospitali?ation*)) AND DOCTYPE(*ar*) AND PUBYEAR > *2004* AND LANGUAGE(*english* OR *german*)	902
#2	(TITLE-ABS-KEY (((human OR adult* OR men OR women OR people OR person* OR population * OR patient* OR citizen* OR resident*) AND ((elder* OR old* OR age*) AND ((60 W/0 year*) OR (65 W /0 year*) OR (70 W /0 year*) OR (75 W /0 year*) OR (80 W /0 year*)))) OR (senior* OR pensioner* OR retire*))) AND (TITLE-ABS-KEY (“climate change" OR "global warming") OR TITLE-ABS-KEY ((extreme OR wave* OR tropical) W /1 (weather OR heat OR temperature* OR night*) OR "urban heat island") OR TITLE-ABS-KEY (storm* OR (heavy W /2 (rain* OR precipitation))) OR TITLE-ABS-KEY (flood* OR (storm W /0 water))) AND (TITLE-ABS-KEY(health* OR mortality OR morbidity OR disease*) OR TITLE-ABS-KEY(((emergenc* OR hospital*) W/2 (number* OR count OR quantity OR admission*)) OR hospitali?ation*)) AND DOCTYPE(*ar*) AND PUBYEAR > *2004* AND LANGUAGE(*english* OR *german*)	104
#3	(TITLE-ABS-KEY(((human OR adult* OR men OR women OR people OR person* OR population * OR patient* OR citizen* OR resident*) AND ((elder* OR old* OR age*) AND ((60 W/0 year*) OR (65 W/0 year*) OR (70 W/0 year*) OR (75 W/0 year*) OR (80 W/0 year*)))) OR (senior* OR pensioner* OR retire*))) AND (TITLE-ABS-KEY((rail* OR environment* OR traffic OR transport* OR (air W/0 craft) OR road OR recreation* OR leisure OR neighbor* OR industr* OR construction*) W/1 noise) OR TITLE-ABS-KEY(((low W/0 frequen*) OR infrasound) W/2 (living OR environment* OR noise))) AND (TITLE-ABS-KEY(health* OR mortality OR morbidity OR disease*) OR TITLE-ABS-KEY(((emergenc* OR hospital*) W/2 (number* OR count OR quantity OR admission*)) OR hospitali?ation*)) AND DOCTYPE(*ar*) AND PUBYEAR > *2004* AND LANGUAGE(*english* OR *german*)	60
#4	(TITLE-ABS-KEY(((human OR adult* OR men OR women OR people OR person* OR population * OR patient* OR citizen* OR resident*) AND ((elder* OR old* OR age*) AND ((60 W/0 year*) OR (65 W/0 year*) OR (70 W/0 year*) OR (75 W/0 year*) OR (80 W/0 year*)))) OR (senior* OR pensioner* OR retire*))) AND (TITLE-ABS-KEY(arsenic) OR TITLE-ABS-KEY(PCB OR (polychlorinated W/0 biphenyl*) OR (*chlorine W/0 compound*)) OR TITLE-ABS-KEY(PFC OR PFAS OR PFOA OR (*flurinated W/0 (chemical* OR alkyl))) OR TITLE-ABS-KEY(phthalate* OR plasticizer*) OR TITLE-ABS-KEY((bisphenol W/0 A) OR BPA)) AND (TITLE-ABS-KEY(health* OR mortality OR morbidity OR disease*) OR TITLE-ABS-KEY(((emergenc* OR hospital*) W/2 (number* OR count OR quantity OR admission*)) OR hospitali?ation*)) AND DOCTYPE(*ar*) AND PUBYEAR > *2004* AND LANGUAGE(*english* OR *german*)	218

Tabelle 32: LIVIVO Suche am 26.11.2018

Set	Search String	Anzahl Treffer
#1	MESH=aged AND MESH=(Air Pollution OR Particulate Matter OR Nitrogene Dioxide OR Ozone OR Cadmium OR Lead OR Volatile Organic Compounds OR Benzene OR Inhalation Exposure) AND MESH=(Health OR Morbidity OR Mortality OR Disease OR Emergencies OR Hospitalisation) AND PY=2004:2018	1.914
#2	((MESH=aged AND MESH=(Climate Change)) AND MESH=(Health OR Morbidity OR Mortality OR Disease OR Emergencies OR Hospitalisation)) AND PY=2004:2018	147
#3	MeSH (aged) AND MeSH (Noise) AND MeSH (Health OR Morbidity OR Mortality OR Disease OR Emergencies OR Hospitalisation) AND JAHR (von 2004 bis 2018)	529
#4	MeSH (aged) AND MeSH (Arsenic OR Polychlorinated Biphenyls OR Fluorocarbons OR Plasticisers OR “bisphenol A”) AND MeSH (Health OR Morbidity OR Mortality OR Disease OR Emergencies OR Hospitalisation) AND JAHR (von 2004 bis 2018)	389

Tabelle 33: Google Suche

Set	Search String	Datum	Treffer insgesamt	relevante Seiten (in 50)
1.1	aged Climate Change Health/Sprache: Englisch	31.01.2019	129.000.000	29
1.2	aged Climate Change Health/Sprache: Deutsch	31.01.2019	129.000.000	0
1.3	aged Climate Change Hospitalisation/Sprache: Englisch	31.01.2019	854.000	10
1.4	aged Climate Change Hospitalisation/Sprache: Deutsch	31.01.2019	854.000	0
2.1	aged chemical Health /Sprache: Englisch	16.01.2019	81.000.000	7
2.2	aged chemical Health /Sprache: Deutsch	17.01.2019	80.900.000	8
2.3	aged chemical Hospitalisation /Sprache: Englisch	17.01.2019	1.270.000	10
2.4	aged chemical Hospitalisation /Sprache: Deutsch	25.01.2019	k. A.	4
3.1	aged Noise Health /Sprache: Englisch	09.02.2019	202.000.000	9
3.2	aged Noise Health /Sprache: Deutsch	13.02.2019	311.000.000	15
3.3	aged Noise Hospitalisation/Sprache: Englisch	15.02.2019	499.000	7
3.4	aged Noise Hospitalisation/Sprache: Deutsch	15.02.2019	523.000	1
4.1	aged Air Pollution Health /Sprache: Englisch	16.02.2019	54.600.000	8
4.2	Suchbegriffe: aged Air Pollution Health /Sprache: Deutsch	16.02.2019	46.700.000	9
4.3	Suchbegriffe: aged Air Pollution Hospitalisation/Sprache: Englisch	17.02.2019	1.210.000	13
4.4	Suchbegriffe: aged Air Pollution Hospitalisation/Sprache: Deutsch	17.02.2019	1.210.000	10

Tabelle 34: Google Scholar Suche

Set	Search String	Datum	Treffer insgesamt	relevante Seiten (in 50)
1.1	elderly Climate Change Health/Sprache: Englisch	02.03.2019	378.000	16
1.2	elderly Climate Change Hospitalisation/Sprache: Englisch	11.03.2019	9.290	5
2.1	elderly chemical Health/Sprache: Englisch	01.03.2019	910.000	11
2.2	elderly chemical Hospitalisation/Sprache: Englisch	01.03.2019	19.100	3
3.1	elderly Noise Health/Sprache: Englisch	12.03.2019	354.000	12
3.2	elderly Noise Hospitalisation/Sprache: Englisch	14.03.2019	7.860	1
4.1	elderly Air Pollution Health /Sprache: Englisch	14.03.2019	158.000	42
4.2	elderly Air Pollution Hospitalisation/Sprache: Englisch	15.03.2019	5.360	15

B Anhang Suchergebnisse

B.1 Studien zur Vulnerabilität Älterer gegenüber Chemikalien

B.1.1 Übersicht zu den Ergebnissen der Studien

Bisphenol A	**Morbidität**	E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Lee, M.-R. et al.	2015	60 years or older: urinary BPA levels were significantly associated with overweight in elderly women after adjustment for possible confounders (OR 1.25; 95 % CI 1.09, 1.45), but not in the men; overweight increased with quartiles of BPA in women (quartile 2 vs 1: OR 1.54; 95 % CI 1.02–2.32, 3 vs 1: OR 1.70; 95 % CI 1.10–2.62, and 4 vs 1: OR 1.81; 95 % CI 1.13–2.92)	+	+
Ahmadkhaniha, Reza et al.	2014	clear association between hypertension, and type 2 diabetes (P<0.05); odds ratio for type-2 diabetes mellitus associated with the group 1 (referent), of urinary Bisphenol A was 57.6 (95 % confidence interval: 21.10-157.05; P-value <0.001); positive correlation between HbA1c and urinary BPA concentration was observed (r = 0.63, P = 0.001)	+	+++

Bisphenol A	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	5

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Wang, Tiange et al.	2015	Two age groups: <> 60 years; negative associations of BPA exposure with hypertension and early macrovascular diseases: urinary BPA concentration (median value of urinary BPA concentration: age <60 years, 0.90 [IQR, 0.55, 1.57] vs age >60 years, 0.71 [IQR, 0.41, 1.26], P<0.0001	-	++
Bae, Sanghyuk et al.	2012	Age: > 60 years: exposure to BPA is associated with decreased HRV and increased blood pressure: odds ratio of showing hypertension was 1.27 (95 % CI, 0.85–1.88) in the fourth quartile compared with the first quartile of urinary BPA concentration. participants who did not report previous history of hypertension, the odds ratio was increased to 2.35 (95 % CI, 1.33–4.17)	+	+
Bae, Sanghyuk et al.	2015	BPA concentration after consuming CC (Dosen) and CG was significantly higher than that after consuming GG (Glasflaschen) (P<0.0001). ΔSBP was significantly higher after consuming CC by 5.0 mm Hg compared with that	+	++++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		after consuming GG (P=0.0160); parameters of HRV did not show significant differences		
Olsen, Lena et al.	2012	Age: 70 years: three of the phthalate metabolites were associated with coronary risk factors: MMP to LDL-cholesterol ($p<0.0001$), MEP to diastolic blood pressure ($p<0.0002$), and MiBP to fasting glucose ($p<0.0001$) remained significant. MMP was associated to the Framingham Risk Score- FRS ($p=0.02$), but after Bonferronni correction, this association was not significant. no strong associations between BPA nor any of the four phthalate metabolites and Framingham Risk Score in this elderly population	+/0	++
Lind, P. Monica et al.	2011	Age: 70 years; Mono-methyl phthalate (MMP) was significant related to carotid plaques ($p = 0.004$). High levels of BPA, mono-isobutyl phthalate (MiBP) and MMP were associated with an echogenic IM-GSM and plaque GSM, while high levels of mono-2-ethylhexyl phthalate (MEHP) were associated with an echolucent IM-GSM and plaque GSM ($p < 0.0001$ after adjustment)	+	++

per- und polyfluorierte Chemikalien	**Morbidität**	C00-D48 Neubildungen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Ducatman, Alan et al.	2015	Two age groups: 20–49, 50–69 years. associations PFAA/PSA are not significant for both age groups.	0	++

per- und polyfluorierte Chemikalien	**Morbidität**	E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten	6

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Eriksen, Kirsten T. et al.	2013	statistically significant positive associations between PFOA and PFOS levels and total cholesterol; Effect: 4.4 [95 % CI = 1.1–7.8] higher concentration of total cholesterol (mg/dL) per interquartile range of plasma PFOA ($p=0,01$); Effect PFOS: 4.6 [95 % CI =0.8;8.5] ($p=0.02$)	+	++
Lind, Lars et al.	2014	Age: 70 years; significant non-linear relationship between PFNA and diabetes, after adjusting for the multiple risk factors (OR 1.25, 95 % CI 1.08, 1.44, $p=0.002$)	+	++
Fisher, Mandy et al.	2013	concentration levels of PFOA PFOS PFHxS increased with age ($p<0.0001$), higher income, Caucasians, and obese or overweight participants and in males; no association with metabolic syndrome, or glucose homeostasis parameters	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Li, Yangjie et al.	2017	Age: 0-90 years; significant increase was observed for ∑8PFASs, PFOS, and PFHxS concentrations with age ($p<0.01$); mean concentration of ∑ 8PFASs was 1.5 times greater in males (6.02 ng/mL, n = 55) than in females (4.15 ng/mL, n = 147) ($p<0.01$); For all donors (0–90 yrs), the mean concentration of ∑ 8PFASs was 2.7 times greater in the elders (60–90 yrs) (5.65 ng/mL) than in infants (0–1 yrs) (2.12 ng/mL), and PFOS ($r = 0.29$, $p < 0.01$), PFHxS ($r = 0.34$, $p < 0.01$) and ∑ 8PFASs ($r = 0.23$, $p < 0.01$) concentrations were also found to be significantly higher with age; no significant association between age and PFOA and the other five PFASs	+	++
Knox, Sarah S. et al.	2011	Two age groups: <> 50 years; significant positive association between serum PFOA and thyroxine in women in both age groups ($\beta = 0.05$, p = < 0.0001; and $\beta = 0.08$, $p < 0.0001$ for women ≤ 50 and > 50, resp.) and in men > 50 ($\beta = .06$, $p = 0.001$), after adjustment for covariates; PFOS is positively associated with thyroxine in both men and women of all ages ($\beta = 0.14$, $p < 0.0001$ and $\beta = 0.08$, $p < 0.0001$ for women ≤ 50 and women > 50 respectively; $\beta = 0.05$, $p = 0.0001$ for men in both age groups)	+	+++
Lewis, R. C. et al.	2015	Various age groups; the majority of the adjusted models were not statistically significant ($p>0.05$) Median concentrations of PFASs were higher in males compared with females within each age category, except for levels of PFOA among the 60 to 80 year-olds, and PFNA among the 12 to <20 and 60 to 80 year-olds; PFOA was also positively related to FT3 (1.8, 95 % CI: 0.2, 3.4) and TT3 (3.3, 95 % CI: 0.6, 6.0 %) among 60 to 80 year-old females	+	++

per- und polyfluorierte Chemikalien	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Lind, P. M. et al.	2018	Age: 70 years: Intima Media Thickness increased 0.058 mm during the 10-year period ($p<0.0001$); change in plasma levels of 6 of 8 PFASs during 10 years was positively related to increase in IMT ($p<0.0062$)	+	++

per- und polyfluorierte Chemikalien	**Mortalität**	Diverse	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Raleigh, Katherine K. et al.	2014	For all cancers little evidence that exposure to APFO increased the risk of cancer; all causes (SMR=0.85, 95 % CI 0.80 - 0.90), all cancers (SMR=0.87, 95 % CI 0.78- 0.97), and ischemic heart disease (SMR=0.84, 95 % CI 0.74 -0.95); diabetes (SMR=1.42, 95 % CI 1.09 - 1.81)	0	++

PCB (polychlorierte Biphenyle)	**Morbidität**	C00-D48 Neubildungen	4

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Laden, Francine et al.	2010	Age: > 65 years (32 %); association of PCB confounders and breast cancer; PCB174 and PCB177 2-fold increase in 5-year all-cause mortality; PCB174 two- to three-fold increase hazard of breast cancer-specific mortality; PCB118 decreased hazards for 15-year all-cause mortality; PCB174 and PCB177 increased 15-year breast-cancer specific mortality, less than 2-fold increase	0	++
Parada, Humberto et al.	2016	OR for breast cancer slightly elevated for premenopausal white women with CYP1A1 M2-containing genotypes and PCB greater than the median, and postmenopausal African American women with M3-containing genotypes and total PCB greater than the median	+	++
Li, Yu et al.	2005	Age: > 64 years (34 %); telomere length inversely associated with age; serum PCB concentrations associated with longer leucozyte telomere length; effect limited to white participants; PCBs 105, 118, 167, 99, 153, 183, 187, 196, and 199 associated with significantly longer relative leucozyte telomere length among whites; PCB 118 only associated with longer telomeres in oldest African American groups; no effect of age, sex or BMI observed	0	++
Callahan, Catherine L. et al.	2017	Age: > 65 years (32 %); association of PCB confounders and breast cancer; PCB174 and PCB177 2-fold increase in 5-year all-cause mortality; PCB174 two- to three-fold increase hazard of breast cancer-specific mortality; PCB118 decreased hazards for 15-year all-cause mortality; PCB174 and PCB177 increased 15-year breast-cancer specific mortality, less than 2-fold increase	0	+++

PCB (polychlorierte Biphenyle)	**Morbidität**	E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Lee, Duk-Hee et al.	2012	Age: 70 years: associations between exposure to less chlorinated PCBs, p,p'-DDE, and dioxin and prevalent abdominal obesity in men and women; OR for OCDD of 2-3	+	+
Silverstone, Allen E. et al.	2012	Age: > 65 years (30 %); nonmonotonic increase in the prevalence of diabetes with increasing PCB congener levels in the total group after adjustment for established diabetes risk factors; women had increased likelihood of diabetes	+	+++

PCB (polychlorierte Biphenyle)	**Morbidität**	F00-F99 Psychische und Verhaltensstörungen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Lin, K.-C. et al.	2008	Age: 60 years: Decreased cognitive functions in women exposed to PCB 25 years earlier, when adjusted for age and education; no difference found in men	0	++

PCB (polychlorierte Biphenyle)	**Morbidität**	G00-G99 Krankheiten des Nervensystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Hatcher-Martin, Jaime M. et al.	2012	Age: > 75 years: Increased concentrations of PCB congeners 153 (2.08 fold higher; p = 0,006) and 180 (2.49 fold higher; p = 0,003) in brain tissue of Parkinson´s disease patients post-mortem	+	++

Schwermetalle	**Morbidität**	C00-D48 Neubildungen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Khlifi, Rim et al.	2013	Age: > 60: As and Ni levels in healthy tissues were correlated with age (p=0.001 and 0.050, resp.) no significant difference between tumor and healthy tissue Cr levels and these four age groups (p>0.05)	0	++

Schwermetalle	**Morbidität**	E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Yuan, Yu et al.	2018	Age: < 65; > 65 years, In the subgroup analyses no significant interaction was observed on diabetes risk (all P interaction > 0.10)	0	+++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Rotter, Iwona et al.	2015	no statistically significant differences in the concentrations of heavy metals (Pb, Cd, Hg, As and W) between the men with MS (as well as those with the components of the MS, such as hypertension, obesity and diabetes) and healthy participants	0	++

Schwermetalle	**Morbidität**	F00-F99 Psychische und Verhaltensstörungen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Baum, Larry et al.	2010	AD patients had significantly lower levels of zinc p<0.0001; Mini–Mental State Examination (MMSE) scores were significantly correlated with aluminum (Pearson's correlation coefficient: -0.33, p = 0.03) and arsenic (0.55, p=0.0001)	+	+++

Schwermetalle	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Mordukhovich, Irina et al.	2012	arsenic may be associated with BP; Hypertension: arsenic OR = 1.07, 95 % CI: 0.97, 1.20; cadmium OR = 1.01, 95 % CI: 0.95; lead OR = 1.00, 95 % CI: 0.92, 1.08	+	+
Shiue, Ivy	2014	Schwermetalle: urinary cesium (OR 1.56, 95 %CI 1.11–2.20, P = 0.014), molybden (OR 1.46, 95 %CI 1.06–2.01, P = 0.023), manganese (OR 1.42, 95 %CI 1.09–1.86, P = 0.012), lead (OR 1.58, 95 %CI 1.28–1.96, P < 0.001), tin (OR 1.44, 95 %CI 1.25–1.66, P < 0.001), antimony (OR 1.39, 95 %CI 1.10–1.77, P = 0.010), and tungsten (OR 1.49, 95 %CI 1.25–1.77, P < 0.001) concentrations were observed to be associated with high BP; Phtalate: higher urinary mono-2-ethyl-5-carboxypentyl phthalate (OR 1.33, 95 %CI 1.00–1.62, P = 0.006), mono-n-butyl phthalate (OR 1.35, 95 %CI 1.13–1.62, P = 0.002), mono-2-ethyl-5-hydroxyhexyl (OR 1.25, 95 %CI 1.05–1.49, P = 0.014), mono-n-methyl phthalate (OR 1.26, 95 %CI 1.07–1.48, P = 0.007), mono-2-ethyl-5-oxohexyl (OR 1.25, 95 %CI 1.07–1.48, P = 0.009), and monobenzyl phthalate (OR 1.40, 95 %CI 1.15–1.69, P = 0.002) tended to have high BP	+/+	++

Weichmacher/Phthalate	**Morbidität**	E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Lind, P. Monica et al.	2012	Age: 70 years: women: mono-isobutyl phthalate (MiBP) were positively related to waist circumference, total fat mass and trunk fat mass, to subcutaneous adipose tissue (all $p<0.008$); no statistically significant relationships were seen in men	+	++
James-Todd, Tamarra M. et al.	2016	participants with MetS (32 % of the study population) had higher concentrations for all urinary phthalate metabolites; no associations reached statistical significance for women ≥50 years of age	0	++

Weichmacher/Phthalate	**Morbidität**	F00-F99 Psychische und Verhaltensstörungen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Kim, Kyoung-Nam et al.	2016	Age > 60 years: mono-(3carboxypropyl) phthalate (MCPP) (OR=1.24, 95 % CI=1.02–1.52) and mono(carboxynonyl) phthalate (MCNP) (OR=1.42, 95 % CI=1.15–1.75) were positively associated with depression	+	++

Weichmacher/Phthalate	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Wiberg, Bernice et al.	2014	Age: 70 years: phthalate MBzP was related to intima-media thickness (IMT) ($p=0.034$). MBzP were also strongly associated with an echogenic IM-GSM and plaque GSM ($p=0.0001$)	+	+

Weichmacher/Phthalate	**Morbidität**	J00-J99 Krankheiten des Atmungssystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Park, Hye Yin et al.	2013	Age: > 60 years: effect of P DEHP on lung function was significant only in subjects with certain genotypes, and having all significant genotypes in three genes showed significant difference in the phthalate-pulmonary function association (FEV1/FVC: $\beta=-2.169$, $p=0.0032$; FEF25–75: $\beta=-0.155$, $p=0.0103$)	+	+

Weichmacher/Phthalate	**Morbidität**	R00-R99 Symptome und abnorme klinische und Laborbefunde, die anderenorts nicht klassifiziert sind	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Li, Ningning et al.	2017	Age groups: 20-40; 40-60; > 60 years; for the age group > 60 years: the monomethylphthalate (MEP), mono (2-ethyl-5-carboxypentyl) phthalate (MECPP) concentrations were significantly correlated with serum AMH concentrations in models both with and without covariates (all $p<0.05$); exposure to phthalates might have negative effects on AMH level, especially in seniors; no significant relationships had been observed in either age 20–40 or age 40–60	+	++
Scinicariello, Franco et al.	2016	Age: > 60 years, MBP and MBzP were associated with higher LTL in older participants Age ≥ 60 years (p trend 0,046; 0,07); age independent association between longer LTL and MEHP	+	+++

persistente organische Schadstoffe (POP)	**Morbidität**	D50-D90 Krankheiten des Blutes und der blutbildenden Organe sowie bestimmte Störungen mit Beteiligung des Immunsystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Kumar, Jitender et al.	2014	Age: 70 years: TEQ-values: positively correlated with C3a (β= 0.07; 95 % CI = 0.017-0.131, p= 0.001) and C3a/C3 ratio (β= 0.07, 95 % CI = 0.015-0.126, p= 0.01)	+	+

persistente organische Schadstoffe (POP)	**Morbidität**	E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten	6

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Ronn, Monika et al.	2011	Age: 70 years - Multiple associations between POPs and fat mass: positively related: OCDD, PCBs: 74, 99, 105, 118; pesticides: HCB, TNK, DDE /negatively related: PCBs: 126,153,156,157,169,170,180,189,194,206,209 /Median concentrations POPs: 325 ng/g lipid (DDE); 250 ng/g lipid (PCB 153); 215 ng/g lipid (PCB 180) /HCB, TNK and products of DDT were all positively related to total fat mass (p-value 1 = 0.029-0.0001)	+	+++
Lind, Lars et al.	2017	Mean age: 70 years; 92 incident cases of MetS; PCB126, PCB170, HCB, PCB118 associated with incident MetS in an additive fashion (OR 1.73 for change from 10 to 90 %) (95 % CI 1.24-3.04) for PCB 126, OR 0.63 (0.42-0.78) for PCB170, OR 1.44 (1.09-2.20) for HCB and OR 1.46 (1.13-2.43) for PCB118	+	++
Lee, Duk-Hee et al.	2011	Age: 70 years: exposure to some POPs substantially increased risk of future type 2 diabetes in an elderly population; adjusted OR (95 % CI) for PCBs were: 4.5, 5.1, 8.8 (1.8-42.7), and 7.5 (1.4-38.8), Ptrend < 0.01	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		/Adjusted OR for OCs were (95 % CI): Ptrend = 0.03; 1.1, 1.6, 1.5, 3.4 (1.0-11.7) (Ptrend = 0.03)		
Langer, P. et al.	2007	Median age: 50/51 years; positive association between PCBs with FT4 and TT3; PCB-category <530 ng/g: Association between PCBs and FT4 (p<0.09) and TT3 (p<0.03) was negative. Positive association (531-2000 ng/g) between PCBs and FT4 (p<0.001) and TT3 (p<0.05) /highly significant (p<0.001) association of PCBs with FT4 in level 1001–101414 ng/g and 001–101414; TT3 only significant in the category 531–2000 ng/g	+/0	+++
Turyk, Mary E. et al.	2007	Two age groups: <> 60 years, inverse association of total T4 with exposure to TEQs. Women: mean T4: 8.2 µg/dL, levels were on average 0.75 µg/dL lower (95 % CI, 0.04-1.46), results stronger in older people	+	+++

persistente organische Schadstoffe (POP)	**Morbidität**	G00-G99 Krankheiten des Nervensystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Medehouenou, Thierry Comlan Marc et al.	2014	Age: > 65 years; Marginal protective effects, but overall no association between plasma concentrations (PCBs/OC pesticides + metabolites) and the prevalence of dementia/AD. Significantly reduced prevalence of dementia: some OC pesticides + metabolites (hexachlorobenzene, cis-nonachlor (p=0.01), 1,1,1-trochloro-2,2-bis(p-chlorophenyl)ethane) (CI 95 %)	0	++

persistente organische Schadstoffe (POP)	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	6

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Lee, Duk-Hee et al.	2012	Age: 70 years; 35 subjects: Development of stroke (cumulative incidence 3.9 %); some POPs: statistical significance, but inconsistent pattern; PCBs (4,5,6 chlorides): positive associations with stroke /OCs: p,p'-DDE, trans-nonachlor: singificant prediction of future stroke; adjusted ORs pf p,p'-DDE: 3.7 (95 % CI: 1.0-13.6), 2.5 (0.6-9.8) and 3.7 (1.0-13.8) /trans-nonachlor: adjusted OR 3.8 (1.3-11.5) HCB: not significant. OCDD: adjusted OR: 1.0, 2.8 (0.9-9.2), 2.3 (0.7-7.7) and 3.5 (1.1-11.7), BDE47 not associated with stroke	+/0	+
Lind, P. Monica et al.	2014	Age: 70 years: PCB (105; 118) related to prevalent hypertension; OC (p,p'-DDE) also related to hypertension (OR 1.35 for 1 SD change, 95 % CI 117-	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		156, $p < 0.0001$; 1.23 for 1 SD change, 95 % CI, 1.06-1.43, p=0.006 after adjustment)		
Mobacke, I. et al.	2018	Age: 70 years: None of the 8 PFASs were significantly related to left ventricular mass /PFNA (p = 0.0018); PFDA (p=0.0009) and PFUnDA (p=0.001) -> significantly related to RWT in a negative way	0	++
Lind, P. Monica et al.	2012	Age: 70 years: 7 POPs (PCB congeners 153, 156, 157, 170, 180, 206, 209) significantly associated with the number of carotid arteries with plaques (CI 95 %, p = 0.002-0.0001); highly chlorinated PCBs (congeners 194, 206, 209) were associated with an echolucent IM-GSM (CI 95 %, $p < 0.0001$)	+	++
Lind, Ylva Sjoberg et al.	2013	Age: 70 years: PCB (congeners 99,118,105,138,153,180) and OCCD were significantly related to a decreased left ventricular ejection fraction (EF) ($p < 0.05$-0.001, CI 95 %). PCB 206 (p = 0.0077) and PCB 209 (p=0.0064): related to a decreased E/A-ratio (CI 95 %)	+	++
Lind, Ylva Sjoeberg, Lind, Lars et al.	2013	Age: 70 years: Several POPs related to abnormal left ventricular geometry, but not significant after adjustment. HCB: significantly related to RWT ($p < 0.0001$)	0/+	++

persistente organische Schadstoffe	**Morbidität**	K00-K93 Krankheiten des Verdauungssystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Kumar, Jitender et al	2014	Age: 70 years: mono-ortho PCB TEQ: significantly positively associated with bilirubin (β = 0.71, P=0.008); OC concentrations negatively associated with ALP (β= -0.02, P= 0.002)	+	+

persistente organische Schadstoffe	**Morbidität**	R00-R99 Symptome und abnorme klinische und Laborbefunde, die anderenorts nicht klassifiziert sind	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Shin, Ji-Yeon et al.	2010	Age: 42-69 years; mean age: 56 years; No association of demographic and health behavior with telomere length; p,p'-DDE (r=+0.31), heptachlorepoxide (r=+0.27), oxychlordane (r=+0.24), trans-nonachlor (r=+0.23) statistically significant. /10/17 PCB congeners: positively and significantly associated with telomer-length	+	+++

persistente organische Schadstoffe	**Morbidität**	Diverse	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
van Larebeke, Nik et al.	2015	Age: 50-65 years; Dioxin-like activity in serum: positively correlated with cancer risk (women); Adjusted ORs: exposure ration (90th percentile) 2.4 times higher than 10 % percentile; HCB: significant risk diabetes, hypertension, p,p'-DDE: singificant for diabetes, hypertension in men (women : p > 0.63); PCB118: significant for diabetes, hypertension	+	+
Shiue, Ivy	2015	Age: 60-80 years (1791 of 4566). Out of 4566: 541 (11.9 %) poor teeth health; 1020 (22.4 %) fair teeth; 2993: (65.7 %) good teeth //19,1 %: Parodonthitis; 13.3 % bone loss mouth (CI 95 %)	+	++

persistente organische Schadstoffe	**Mortalität**	I00-I99 Krankheiten des Kreislaufsystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Kim, H.-W. et al.	2017	Association between the albumin creatinine ratio ACR and all-cause mortality became stronger as the serum levels of POPs, especially OCPs (p interaction < 0.01); elderly T3: 1.0; 1.1: 2.9, (p-trend < 0.01); ACR not clearly related to mortality within T1	+	+

persistente organische Schadstoffe	**Mortalität**	Diverse*	4

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Kim, Se-A et al.	2015	Mean age: 77 years; of 633 patients with information on PCBs: 143 died (22.5 %) (50: CVD, 34 cancer, 17 respiratory, 42 others) /patients with information on OC: 146 (21.6 %) died: 56: CVD; 32 cancer /neither PCBs nor OC pesticides were associated with total mortality when fat mass was not considered in the analyses; associations of PCBs and OC pesticides with total mortality depended on fat mass (P interaction < 0.01 and 0.06)	0	+
Lin, Yu-Sheng et al.	2012	Three age groups: 40-54; 55-65; > 65 years; Distribution serum dioxin-like chemical concentration (pg TEQ/g lipid) age: 40-54: 15.5 (11.3-21.0); 55-65: 19.8 (15.0-27.8); 28.5 (20.0-39.0) p < 0.001 /median TEQ: 19.2 pg/g (13.3-27.9); > 65: 28.5 (20.0-39.0) p<0.001	+	+++
Fry, Kristiann; Power, Melinda C.	2017	Age > 60 years: among 483 patients, 25.7 % died Beta-hexychlorocyclohexane was associated with an increased risk of all-cause-mortality (HR per 1 SD	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		increase= 1.18, 95 % CI= 1.01, 1.38) oxychlordane(HR= 1.15 95 % CI 1.06, 1.25) p,p'-DDE (HR= 1.12, 95 % CI = 1.02, 1.23), trans-nonachlor (HR= 1.11, 95 % CI = 1.04, 1.18), beta-hexachlorocyclohexane (HR= 1.25, 95 % CI = 1.03, 1.52) --> increased with risk of other-cause-mortality		
Hong, N.-S. et al.	2012	Age: 70 years; 150 deaths /635 patients with information on PCDDs, PCDFs, PCBs --> 51: CVD, 39: cancer, 17, respiratory disease, 43: other /135 deaths /652 patients with information on OCPs /adjusted HR (lowest fat mass): 1.0, 0.8, 0.6 (95 % CI; 0.3-0.9), 0.9 & 0.9 across fat mass quintiles /adjusted HR (fat mass): 1.0; 1.8; 2.0; 3.0 (95 % CI: 1.2-7.8) & 1.6 across fat mass quintiles among the elderly within the lowest tertile of heptachlor epoxide (OCPs)	+	+

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B.2 Studien zu Vulnerabilität Älterer gegenüber Klimawandel

B.2.1 Übersicht zu den Ergebnissen der Studien

Hitzebelastungen	**Gesundheitsinfrastruktur**	F00-F99 Psychische und Verhaltensstörungen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Chan, Emily Y. Y. et al.	2018	Age: 60-74 years (16.39 %); > 75 years (36.19 %) old. mental-disorder admissions: Temperature was positively associated with overall mental-disorder hospitalizations (cumulative relative risk at 28 ◦C vs. 19.4 ◦C (interquartile range, lag 0–2 days) = 1.09 (95 % confidence interval 1.03, 1.15)), with the strongest effect among the elderly (≥75 years old). The lagged 0–2 days RR at 28 ◦C (vs. 19.4 ◦C) for the elderly and adults were 1.20 (1.09, 1.31) and 1.06 (0.98, 1.15), respectively	+	+

Hitzebelastungen	**Gesundheitsinfrastruktur**	I00-I99 Krankheiten des Kreislaufsystems	7

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Zheng, Shan et al.	2016	Two age groups: 65-74; > 75 years; 8.96 and 11.19 ER admissions per day for people aged 65–74 years and >75 years; Diurnal temperature range and daily emergency room admissions significant for cardiovascular and cerebrovascular disease among elderly; > 75 years more vulnerable to DTR; A 1°C increase in the 2-day and 3-day moving average of DTR (lag 01 and lag 02) corresponded to a 1.46 % (95 % CI: 0.74 %~2.19 %) increase in all cardiovascular disease ER admissions	+	+
Lam, Holly Ching Yu et al.	2018	DM patients had a higher increased risk of AMI admissions than non-DM patients during extreme temperatures; non-DM patients, there were no obvious differences in relative risks between age groups, genders, and admission types; differences	0	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		in sensitivity to temperature between patients with DM and without DM were most apparent in the group <75 years old		
Wang, Yu-Chun et al.	2018	ERVs are significantly elevated for all OHCA(cardiac arrest) patients; cumulative six-day RRs of ERV were 1.73 (95 % CI: 1.22, 2.46) for all OHCA patients, 1.74 (95 % CI: 1.06, 2.84) for OHCA < 65 years old, and 1.99 (95 % CI: 1.03, 3.81) for subjects with pre-existing hypertension. High temperature was also associated with elevated ERV of OHCA	0	++
Lichtman, Judith H. et al.	2016	Two age groups: 18-64; > 65 years. Increased average temperature was associated with decreased odds of stroke hospitalization among both age groups and across seasons: 18-64 years: each 5°F increase associated with a 7 %-18 % decrease in the odds of stroke (ORs ranging from 0.93, 95 % CI 0.86-1.00 in the summer to 0.82, 95 % CI 0.76-0.88 in the spring); >65 years: a 14 %-17 % decrease in the odds of stroke (ORs ranging from 0.86, 95 % CI 0.82-0.91 in the spring to 0.83, 95 % CI 0.79-0.87 in the winter); Increased diurnal temperature variation was associated with increased odds of stroke hospitalization (nearly all regions, spring to fall)	0	++
Liu, Xiaole et al.	2018	Two age groups: <> 65 years. No significant association between high temperature and AMI hospitalization; susceptive groups were males and people >65 years: AMI events: <65: 36989, >65: 44040	0	++
Bayentin, Lampouguin et al.	2010	Age: 45-65 years. Women aged 45-65 years were more affected by extreme heat in comparison to men of the same age; Other than this general statement, no specific pattern was discernible; Men aged 45-64 years showed higher risk levels of ischemic heart disease than women	0	++
Brunetti, Natale Daniele et al.	2014	Two age groups: <> 70 years. No significant gender or age (>70 vs <70 years) differences were observed; Increased "118" callings were observed just after peaks in HI index (+87 %, p<0.001); Atrial Fibrillation (AF) were significantly increased after heat peak (23 on July 14 vs 7 on July 1, p <0.01)	0	+++

Hitzebelastungen		**Gesundheitsinfrastruktur**	J00-J99 Krankheiten des Atmungssystem	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Kim, Jayeun et al.	2014	Age: > 65 years years: most prominent effect during the fall, 17.9 % (95 % CI 4.1, 33.6 %) increase in emergency department visits per 1-unit increase of temperature change	0	++

Hitzebelastungen	**Gesundheitsinfrastruktur**	Diverse	12

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Wang, Min-zhen et al.	2013	Age > 65 years: A 1 °C increase in DTR (lag 07) corresponded to an increase of 2.08 % (95 % CI: 0.88 %–3.29 %) in respiratory ER admissions and 2.14 % (95 % CI: 0.71 %–3.59 %) in digestive ER	0	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		admissions. A 1 °C increase in the 3-day and 6-day moving average of DTR (lag 02 and lag 05) corresponded to a 0.76 % (95 % CI: 0.07 %–1.46 %) increase in cardiovascular ER admissions, and 1.81 % (95 % CI: 0.21 %–3.45 %) increase in genitourinary ER admissions, respectively; > 75 years more strongly with DTR than the 65–74 age group		
da Silva, Edelci Nunes et al.	2012	Age > 60 years: No significant association between hospital admissions due to circulatory diseases and meteorological variables was found in the districts with higher socioenvironmental conditions; significant association (p<0.00) with air pollution: the relative risk of high admission rate was 1.36 times greater in days with inadequate air quality	+	++
Son, Ji-Young et al.	2014	Age groups: 0-14; 15-64; 65-74; > 75 years. Heat effects for cardiovascular disease were higher for younger age groups (0–14 and 15–64 years) than older age groups (65–74 and ≥75 years). Higher and statistically significant cold effects also were found in younger persons (0–14 years) for risk of hospital admissions from allergic disease, asthma, and selected respiratory disease, although 95 % intervals among all age groups overlapped.	-	++
Gronlund, Carina J. et al.	2016	Age: > 65 years: two-day EH (extreme heat) effects vs. non-heat, EH was associated with an 8 % (95 % CI 6 %-11 %) increase in hospitalizations for renal/heat/respiratory causes; percentage of hospitalizations among individuals aged 78+ years ranged widely (38 %–60 %)	+	+
DeVine, Aubrey C. et al.	2017	Age: > 65 years. Higher Advanced Life Support (ALS) call volume was found to be significantly associated with a heat day (RR = 1.067, p < 0.001), as well as in locations with higher percent of the population >65 years (RR = 1.057, p = 0.005), and higher percent poverty (RR = 1.041, p = 0.016); Interaction between heat and % population ≥ 65 years old: RR = 1.005, p = 0.446	0	++
Fuhrmann, Christopher M. et al.	2016	heat related illness (visits per 100.000; HRI) during 3 different heat wave events (2007-2011); no age distribution mentioned; elderly (>65) during early summer HRI 8.9; 18-44 years old HRI 6.3 during mid-summer event; elderly -> increase in cardiovascular and cerebrovascular diseases, >60 % of cases from 65+ year old for cardiac dysrythmia, heart failure, hemorrhagic stroke, ischemic stroke, late effects, aneurysm, pneumonia and influenza	0	++
Smith, Sue et al.	2016	Age groups: 64-74; > 75 years. Total heat illness (heat/sunstroke) incidence rate for England, no further information on age distribution; Incidence rate ratios (IRR) -> mean weekly incidence rate per 100.000 population of a heat-wave year compared to non-heatwave years, 65-74 years old IRR 2.4, >75 years old IRR 3.2, all ages IRR 2.5; highest rates in school children and people >75 years old, response in older people delayed and lasting longer	+	++
Xiao, Jianguo et al.	2017	Age groups: 0-14, 15-59, > 60 years. <14 years and >60 years or over were identified as the most vulnerable populations to HWs	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		as shown in ED attendance data: (129.27 (127.98–130.56); 115.61 (114.29–116.92)); 15–59 and >60 years were more at risk of heat- or kidney disease-related hospital admissions than those aged 0–15 years, significant dose–response relationships between HW intensity and SES, remoteness, and health service usage		
Knowlton, Kim et al.	2009	Age: 0 - > 65 years. Children (0–4 years of age) and the elderly (≥ 65 years of age) were at greatest risk; elevated rates of ED visits in the ≥ 65 years age group statewide for diabetes (RR = 1.04; 95 % CI, 1.02–1.06) and respiratory illnesses (RR = 1.04; 95 % CI, 1.02–1.06); ED visits also showed significant increases for acute renal failure, cardiovascular diseases, diabetes, electrolyte imbalance, and nephritis; significantly elevated RRs for hospitalizations for heat-related illnesses (RR = 10.15; 95 % CI, 7.79–13.43), acute renal failure, electrolyte imbalance, and nephritis	+/-	+
Chan, Emily Ying Yang et al.	2011	Age: > 75 years. Health-related callers were mostly >75 years of age (69 %): Threshold max temperature (°C) 30–32	+	+
Bai, Li et al.	2014	RR of high temperature for total emergency room visits and non-external hospitalizations were 1.162 (95 % CI: 1.002–1.349) and 1.161 (95 % CI: 1.007–1.339) respectively, for lag 0–14 days. Those ≥65 years of age were more vulnerable to high temperatures (RR Lag 0 1.221 (1.023–1.457); p<0,05). The strongest cumulative effect of heat for lag 0–27 days was on admissions for infectious diseases (RR: 2.067, 95 % CI: 1.026–4.027). Acute heat effects at lag 0 were related with increases of renal (RR: 1.478, 95 % CI: 1.005–2.174) and respiratory diseases (RR: 1.119, 95 % CI: 1.010–1.240), whereas immediate cold effects increased admission for digestive diseases (RR: 1.132, 95 % CI: 1.002–1.282)	0	++
Zhang, Yue et al.	2014	Age: < 45 years, > 65 years. The effects of high temperature were relatively consistent over all age groups; aged >65 years, a 1°C increase in ambient temperature was associated with a 1.65 % (95 % CI: 1.20 to 2.20) increase in ED visits on the same day; the cold effect appeared to be more acute among younger people aged <45 years, whereas the effects were consistent on individuals aged ≥65 years	0	++

Hitzebelastungen	**Gesundheitsinfrastruktur**	N00-N99 Urogenitalsystem	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Lin, Yu-Kai et al.	2013	Two age groups: <> 65 years. Temperature risks for hospital admissions were similar between younger (<65 years) and elderly (>65 years) population 1.31 (95 % CI: 0.95–1.82) and 1.20 (95 % CI: 0.91–1.59); high temperature effect (<65 years, RR=1.43 vs. 65+years, RR=1.44)	0	++

Hitzebelastungen	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	6

AutorInnen	**Jahr**	**Ergebnisse**	**Effekt**	**Qualität**
Kang, Si-Hyuck et al.	2016	Two age groups: <> 65 years. Age: > 65 years: more susceptible to developing cardiac arrest during heat waves; Interactions were significant for age subgroups: Rate ratios ca. : <65: 1,05 p=0,039 (95 % CI); >65: RR: 1,27 p=0,039 (95 % CI)	+	++
Ha, Sandie et al.	2014	Age groups: > 65; > 80 years; Age: > 65 years: increased risk for stroke hospitalization on Heat day (OR 1.121, 95 % CI 1.013–1.242); more significant > 80 years: heat day OR 1.179 (1.012, 1.374) p<0,05; heat wave: OR 1.191 (1.003, 1.414)	+	+
Smith, Sue et al.	2016	Age groups 65-74; > 75 years: GPIH myocardial infarction consultations in the 65–74 years age group and >75 years in the ED attendances decreased over the heatwave period as the temperature increased; Incidence Rate Ratios (IRRs) GPIH myocardial infarction: >75:1.07 (0.80–1.34), 65–74: 0.77 (0.30–1.23)	0	++
Fink, Rok et al.	2017	relative frequency and magnitude of expressed symptoms is significantly higher in the CVD group in comparison to the no-CVD group	+	+++
Alperovitch, Annick et al.	2009	Age groups: 65-74; > 80 years. Systolic blood pressure decreased with increasing temperature; Outdoor temperature and blood pressure are strongly correlated in the elderly, especially in those > 80 years; For a 15°C decrease in outdoor temperature, SBP increased 0.8 mmHg in subjects aged 65 to 74 years compared with 5.1 mm Hg in the oldest group (>80 years). For a 15°C increase in temperature, SBP decreased 9.9 mm Hg in the youngest group vs 13.8 mm Hg in subjects >80	+	++
Bhaskaran, Krishnan et al.	2010	Age groups: < 65; 65-74; 75-84; > 85 years. Linear relation between temperature and myocardial infarction: each 1°C reduction in daily mean temperature associated with a 2.0 % (95 % confidence interval 1.1 % to 2.9 %) cumulative increase in risk of myocardial infarction; At days 8-14 evidence of a temperature effect was strong RR 1.007 (1.003 to 1.011 (P=0.006); again an increase in the risk of myocardial infarction was seen at lower temperatures; Adults aged 75-84 and those with more vulnerable to the effects of cold than other age groups (P for interaction 0.001 or less in each case), whereas those taking aspirin were less vulnerable (P for interaction 0.007); effect modification by age was strong (P for interaction <0.001); relative risk per 1°C reduction in temperature 1.016(95 % CI 1.007- 1.025) <65, 1.018 (1.009 to 1.027) for 65-74, 1.027(1.018-1.036) 75-84, and 1.019 (1.009 - 1.029) > 85	+	++

Hitzebelastungen	**Morbidität**	J00-J99 Krankheiten des Atmungssystems	3

AutorInnen	**Jahr**	**Ergebnisse**	**Effekt**	**Qualität**
McCormack, Meredith C. et al.	2016	older participants: Increases in maximal indoor temperature were associated with worsening of BCSS- (Breathlessness, Cough, and Sputum Scale score) and increases in rescue inhaler	+	+++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		use (95 % CI, 0.01–0.67; P=0.01); Daily maximal outdoor temperature was not significantly associated with respiratory symptoms, rescue medication use, or lung function in the overall cohort		
Sun, Shengzhi et al.	2018	Age: > 65 years: HRs per 1°c increase in wintertime temperature variability were 1.20 (95 % ci 1.08 to 1.32), 1.15 (1.01 to 1.31) and 1.41 (1.15 to 1.71) for total respiratory diseases, pneumonia and COPD, resp. not statistically significant for summertime temperature variability	0	+
Wang, Yu-Chun et al.	2015	elderly was more vulnerable to high temperature of 30 °C with the cumulative 8-day RR of 1.08 (95 %CI 1.03–1.13) for chronic airway obstruction (CAO); higher RR for >65 years of age at 18°C: 1.18 (1.17–1.20); 1.06 (0.96–1.18), 1.07 (1.00–1.15) Respiratory diseases, Asthma, CAO , resp.	+	++

Hitzebelastungen	**Morbidität**	S00-T98 Verletzungen, Vergiftungen und bestimmte andere Folgen äußerer Ursachen	3

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Belanger, Diane et al.	2014	study population 47 % of total census of Quebec, Kanada; prevalence of physical (44 %) and mental health (17.8 %) impacts during very hot and humid summer conditions among the poor/disadvantaged; 42.1 % health impacts for people over 65 years; prevalence higher in women than men and also higher in Age: > 65 years. one-person households; Odds ratio (OR): chronic disease > 65 OR 1.9, fair/poor health OR 4.2, daily stress OR 1.9	-	+++
Li, Yonghong et al.	2017	Age groups: 0-14; 15-18; 19-35; 35-55; 56-65; > 65 years. People > 65 years had the highest excess risk (ER) and aged 19–35 and 35–55 years also showed significant heat-HS associations; No statistically significant ERs for groups aged 0–14 years, 15–18 years, and 56– 65 years; HS-cases: aged 36– 55 years (39.87 %), 19–35 years (21.11 %), > 65 years old (19.32 %)	+	++
Oberlin, M. et al.	2010	Age: > 65 years: patients with heat-related illnesses 5.5 %; Age, gender, pre-existing disease and diuretic treatment were similar for patients with or without heat-related disease (mean age 82; 79 resp., n.s.)	+	++

Hitzebelastungen	**Mortalität**	I00-I99 Krankheiten des Kreislaufsystems	8

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Dong, Wentan et al.	2016	Two age groups: <> 65 years. Increase of 18 % (95 % confidence interval (CI): 6 %, 31 %) in the overall population, 24 % (95 % CI: 10 %, 39 %) in an older group (ages 65 years), and 22 % (95 % CI: 3 %, 44 %) in a female group, females and the elderly were at higher risk than males and younger subjects (ages <65 years)	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Tam, Wilson W. S. et al.	2009	Age > 65 years: During the 6-year period 76.0 % were aged >65 years (deaths for cardiov. diseases); significant associations between cardiovascular mortality and DTR at lag day 1 and at lag days 0–1 to 0–5. The largest effect was at lag days 0–3 (relative risks = 1.017; 95 % confidence interval = 1.003–1.031);	+	+
Yang, Xunfeng et al.	2015	cardiovascular mortality increased with increasing temperature on hot days and with decreasing temperature on cold days, with certain variations across regions; Regions with less old population (percent change in cardiovascular mortality: less than 5.65 % with a probability of 0.690) have a higher probability of being at high risk than that with more old population (percent change in cardiovascular mortality: more than 5.65 % with a probability of 0.273)	+	++
Davidkovova, Hana et al.	2014	Two age groups: 0-64; > 65 years. Both hot and cold spells were associated with excess IHD mortality; estimated excess mortality associated with an average hot spell is ~40 % of daily mortality; excess mortality associated with an average cold spell is ~140 % of daily mortality; IHD excess deaths were much more pronounced in the > 65 years age group. effects of extreme heat on IHD mortality in age group 0-64 were much less pronounced; AMI-Mortality was elevated in both age groups and the effect of cold was immediate (excess mortality of 20 % on D+ 0 in the younger age group)	+	+
Kynast-Wolf, Gisela et al.	2010	Two age groups: 40-64; > 65 years. All-cause mortality in adults (40–64 years) and the elderly (> 65 years) was 1269 per 100 000 (95 % CI 1156– 1382) and 7074 (95 % CI 6569–7579), resp.; Cardiovascular disease mortality was 205 per 100 000 (95 % CI 168–249) in all adults (> 40), with a mortality of 109.9 (95 % CI 76.6–143.1) for ages 40–64 and 544.9 (95 % CI 404.6–685.1) for ages > 65; monthly temperature was significantly related to mortality in old ages, highest rates occurred in March and April, significant (P < 0.001) seasonal variation for all-cause mortality and a significant (P < 0.05) seasonal variation for CVD mortality in the elderly	+	++
Huang, Jixia et al.	2017	Two age groups: <> 65 years. 1 °C increase above the city-specific heat threshold was associated with average overall CVD mortality increases of 4.6 % (3.0 %–6.2 %), 6.4 % (3.4 %–9.4 %), and 0.2 % (−4.8 %–5.2 %) for all ages, ≥65 years, and <65 years over a lag period of 0–2 days, resp.;	+	++
Huang, Jixia et al.	2014	Two age groups: <> 65 years. 82.5 % of CVD deaths in those ≥65 years, A 1 °C increase in temperature above the hot temperature threshold (29 °C) was associated with increase (three days) in CVD mortality of 4,4 % (95 % CI: 1.3–7.7)p < 0.05 , lag effect of hot temperatures did not affect those < 65 years (n.s.) Low temperatures with 0–2 lag days increased the mortality risk for those ≥65 years and females	+	++
Yang, Jun et al.	2018	Age: > 65 years. Effect of diurnal temperature range on death from stroke: females, the elderly aged ≥ 65 years, lower educational attainment were vulnerable to DTR: 1.09 (0.52, 1.66), 0.81 (0.43, 1.18), 1.28 (0.63, 1.94)	+	++

Hitzebelastungen	**Mortalität**	Diverse	46

AutorInnen	**Jahr**	**Ergebnisse**	**Effekt**	**Qualität**
Linares, C. et al.	2008	effect of temperature on hospital admissions for 1°C maximum daily temperature above 36°C: increase is very small in all age groups, highest values in the >75 from respiratory system diseases (27.5 % IC: (13.3–41.4)); no relationship between heat and admissions due to circulatory causes in all the age groups	0	+
Yang, Jun et al.	2015	Age groups: <> 75 years. Cumulative relative risk of hot effects on mortality to non-accidental, cardiovascular and respiratory mortality for > 75: RR 1.05 (1.02, 1.07), 1.06 (1.03, 1.1), 1.05 (1.01, 1.09) P< 0.05; < 75 n.s.	+	++
Zhou, Xiaodan et al.	2014	Two age groups: 1-64; > 65 years. Total, cardiovascular and respiratory deaths ranged from 19 to 119, 8 to 44, and 2 to15, resp.; no significant association of DTR among males or younger people (1–64 years), effect among females and elderly residents (≥65 years) was approximately 2 times higher; no significant associations in warm seasons for ages; in cool seasons: significant associations between DTR and daily mortality: A 1 °C increment of DTR on lag-day 1 corresponded to a 0.42 % (95 % CI, 0.14 to 0.70) increase in total non-accidental mortality, 0.45 % (95 % CI, 0.26 to 0.65) increase in cardiovascular mortality, and a 0.76 % (95 % CI, 0.24 to 1.29) increase in respiratory mortality in cool seasons	0	++
Johnson, Matthew G. et al.	2016	decedents were disproportionately male (67 % vs. 49 %), aged >= 65 years (46 % vs. 14 %), and unmarried (78 % vs. 47 %). Higher rates of heat-related mortality were observed among Blacks.	+	++
Harlan, Sharon L. et al.	2014	Two age groups: <> 65 years. For direct exposure to heat, the temperature threshold for <65 (ATmax = 93 °F) was 3 °F higher than for age ≥65 (ATmax = 90 °F) with zero lag days. However, for cardiac disease/stroke, the temperature threshold for age <65 (ATmax = 106 °F) was 3 °F lower than for age ≥65 (ATmax = 109 °F) with one-day lags. Similarly, for all-cause deaths, the temperature threshold for age <65 (ATmax = 104 °F) was 3 °F lower than for age ≥65 (ATmax = 107 °F) with one-day lags. The increases in relative risk above threshold temperatures within each category of death were very similar for both age groups. In people age ≥65, there were statistically significant effects of temperature on COPD/asthma deaths (ATmax = 110 °F, lag days = 0, RR = 1.05).	0	+
Yip, Fuyuen Y. et al.	2008	136 heat-related deaths (0.68 per 100,000) were reported	+	++
Hausfater, Pierre et al.	2010	Mean age 79 years (66 % age over 80); hospital admissions during heat wave; 88 % heat-related illness (HRI); 36 % had infections diagnosed, of which 45 % had pulmonary infections; survival rate after one year was 57 % (90 % expected); hazard rate of the cohort decreased over first 3	+	+++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		month (15.9 % to 0.7 %/week) to 0.4 % after 1 year (0.2 %/week for control); identified prognostic factors: previous treatment with diuretics, living in an institution, age >80 years, cartdiac disease, cancer, core temperature >40 °C, systolic arterial pressure <100 mmHg, Glasgow coma scale <12 and transportation to hospital by ambulance		
Vicedo-Cabrera, Ana M. et al.	2016	Age: > 75 years: 804 excess deaths (5.4 %, 95 % confidence interval [CI] 3.0-7.9 %), 77 % of deaths occurred in people aged 75 years and older	+	+
Li, Jing et al.	2017	Age groups: 45-54; 55-64; 65-74; > 75 years. Age-adjusted mortality rates were greatest among decedents ≥75 years (14.4 per 100,000); however, high mortality rates were also observed among those 65–74 years (10.3 per 100,000) and 45–54 years (7.3 per 100,000).	+	++
Kalkstein, Adam J. et al.	2018	Age: > 65 years: average of 4.4 total excess deaths per day with 3.7 excess deaths among.	+	++
Sung, Tzu-I et al.	2013	Age: > 65 years, average risk ratios for the daily mean heat indices of the 95–100th percentile groups were typically elevated, having significant correlations with daily mortality for 5of the 6 cities previously described	+	++
Klein Rosenthal, J. et al.	2014	Significant positive associations were found between the MRR65+ and neighborhood-level characteristics: poverty, poor housing conditions, lower rates of access to air-conditioning, impervious land cover, surface temperatures aggregated to the area-level, and seniors' hypertension.	+	+
Henderson, Sarah B. et al.	2013	Age: < 75 years: effect of temperature was markedly higher in the Dry Plateau, Mountain, and North ecoregions, but not in the Coast ecoregion: MR: 1.04 (0.99–1.10), 1.06 (0.97–1.14) 1.10 (0.98–1.21) 1.09 (1.06–1.11)resp. (with maximum apparent temperatures (ATmax) greater than the 95th percentile)	+/-	+
Conti, S. et al.	2005	there was an overall increase in mortality of 3134 (from 20,564 to 23,698). The greatest increase was among the elderly; 2876 deaths (92 %) occurred among people aged 75 years and older, a more than one-fifth increase (21.3 %, from 13.517 to 16.393 %).	+	++
Sun, Xiaoming et al.	2014	Age: > 80 years. 167 (95 % CI: 46-280) excess deaths, people aged >= 80 years old (excess deaths were 129 (95 % CI: 47-203) and excess mortality was 16.64 %), Females and people aged >= 80 years old were significantly vulnerable to the heat waves.	+	++
Canoui-Poitrine, F. et al.	2006	Age: > 75 years (adjusted OR=1.44 (1.10-1.90), not being married (adjusted OR=1.63 (1.23-2.15)), particularly for men	+	++
Heudorf, U. et al.	2005	Age groups: 60-70; 70-80; 80-90; > 90 years. Age: 60-70 years: excess in mortality was 66 %, 100 % for persons 70 - 80 years old, 128 % in the age group 80 - 90 years and 146 % in persons more than 90 years old	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Urban, Ales et al.	2017	Excess mortality was significantly larger among the elderly: cumulative relative mortality deviation was comparable among the younger and the elderly age groups (254 % and 234 %, respectively) in the 1994_4 heat wave, it was significantly larger (p = 0.05) among the elderly in 2015_3 (132 % and 313 %, respectively).	+/-	++
Monteiro, Ana et al.	2013	Age: > 75 years: Excess of admissions due to respiratory diseases was observed with an increased statistical significance of 2.7 % (95 % CI:0.4–5.1) for the men, and an increase of 3.9 % (95 % CI:1.6–6.3) for women, for each 1°C increase in the heat index	+	++
Fouillet, A. et al.	2006	Age groups: > 35, 35-44, 35-74; > 95 years.From the age of 35 years, the mortality ratios were significantly greater than 1 and increased regularly with age, rising from 1.19 for subjects aged 35–44 years to 2.00 for subjects aged 95 years and over. The number of excess deaths increased very rapidly with age: 11,731 of the 14,729 excess deaths occurred in subjects aged 75 years and over and 2,930 in subjects aged 35–74 years. mortality ratios by age group were much higher for single people than for married people	+	++
D'Ippoliti, Daniela et al.	2010	Age > 65 years, highest effect was observed for respiratory diseases and among women aged 75-84 years (effect of heat waves on daily mortality (61.3 % CI (44.3 -80.4))	+	++
Belmin, Joel et al.	2007	individuals with impaired autonomy: independent factors associated with mortality were grade of dependency, age and sex, RR age community-dwelling 1.015 (1.005–1.025), RR age institutionalised 1.015 (1.007–1.022)	+	++
Rey, Gregoire et al.	2007	Age: > 5, > 75 years. Mortality ratios increased with age for subjects aged over 55 years and were higher for women than for men over 75 years, greatest excess mortality were observed for cardiovascular diseases, neoplasms, respiratory system diseases, HRC, ill-defined conditions and injury and poisoning, mortality ratios (O/E) were highest for HRC, respiratory diseases, nervous system diseases, mental disorders, infectious diseases, and endocrine and nutritional diseases, some populations are particularly vulnerable to HW: the elderly, women and people with some specific diseases	+	++
Laaidi, Karine et al.	2012	Mortality risk of elderly people significantly associated with exposure for two indicators: minimum temperatures averaged [for a 0.41°C increase, OR = 2.17; 95 % confidence interval (CI): 1.14, 4.16] and minimum temperature averaged on the day of death and the 6 preceding days (for a 0.51°C increase: OR = 2.24; 95 % CI: 1.03, 4.87).	+	++
Cheng, Jian et al.	2018	Age: > 75 years: Average death increase of 28 % (95 % confidence interval: 15 % to 42 %), significant associations between heatwave and deaths	+	+
Shaposhnikov, Dmitry et al.	2014	Two age groups: <> 65 years. RR Age ≤ 65: 1,11 (1,06 - 1,17), RR Age > 65: 2,14 (2,06 - 2,23)	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Hutter, Hans-Peter et al.	2007	Two age groups: <> 65 years. Significantly increased relative mortality risk of 1.13 [95 % confidence interval 1.09 - 1.17], excess mortality was seen in all age groups, it reached significance only in the elderly population over 65 years, increase was stronger in females than in males	+	++
Green, Helen K. et al.	2016	Two age groups: <> 65 years. Small cumulative excess of 195 deaths (95 % confidence interval 87 to 477) in >65 year olds and 106 deaths (95 % CI 22 to 234) in <65 year olds, this was not significant	0	++
Bogdanovic, Dragan C. et al.	2013	Age: > 75 years. Total of 167 excess deaths (38 %), people aged 75 years and older accounted for 151(90 %), most vulnerable population group is the elderly females	+	++
Vandentorren, S. et al..	2006	people with pre-existing medical conditions were likely to be vulnerable during heat waves, OR (95 % CI): Cardiovascular disease 3.19 (2,08-4,90); High Blood pressure 1.46 (1,02-2,08); Respiratory condition 1.48 (0,96-2,26); Mental disorder 5.86 (2,75-12,49); Neurological disease 4.67 (2,42-8,99); Liver disease 2,01 (0,8-5,04); Kidney disease 1,64 (0,79-3,4); Cancer 2.79 (1,53-5,08)	+	+++
Schaffer, Andrea et al.	2012	Two age groups: <> 75 years. All-cause ED visits increased by 2 % (95 % CI 1.01-1.03), all-cause ambulance calls increased by 14 % (95 % CI 1.11-1.16), and all-cause mortality increased by 13 % (95 % CI 1.06-1.22). Those aged >75 years highest excess rates of all outcomes: younger age group 10 % increase in the number of ambulance calls (RR 1.10, 95 % CI 1.07-1.13), >75 years a 17 % increase (RR 1.17, 95 % CI 1.12-1.23); number of deaths : <75 years 16 % increase (RR 1.16, 95 % CI 1.02-1.30), >75 years increase of 12 % (RR 1.12, 95 % CI 1.03-1.23)	+	++
Huang, Wei et al.	2010	Two age groups: <> 65 years. Age > 65 years (11,9 %): most vulnerable to the heat wave Mortality (RR=1.13, 95 % CI: 1.06–1.21) not significant effects of heat wave in residents aged < 64	+	++
Kim, Jayeun et al.	2016	Age: > 65 years. Adverse effects of diurnal temperature range were more pronounced for those aged >= 65 years and varied according to geographic, longitudinal (0.07 %; 95 % CI: 0.05, 0.10), and climatic characteristics and the scale of DTR (0.33 %; 95 % CI: 0.12, 0.55) for overall all-cause mortality	+	++
Revich, B. A. et al.	2010	Two age groups. Cardiovascular and non-accidental mortalities increased during both heat waves and cold spells; No significant differences were found between the two analyzed age groups in terms of relative excess mortality.	0	++
Vutcovici, Maria et al.	2014	Age: > 65 years: cumulative increase in daily mortality of 5.12 % [95 % confidence interval (CI): 0.02-10.49 %] for a change from 5.9 A degrees C to 11.1 A degrees C (25th to 75th percentiles) in diurnal temperature, and a 11.27 % (95 %CI: 2.08-21.29 %) increase in mortality associated with an increase of diurnal temperature from 11.1 to 17.5 A	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		degrees C (75th to 99th percentiles), associated with a small increase in non-accidental mortality among the elderly population		
Zhang, Yunquan et al.	2017	females, the elderly (> 75 years old), and those with higher education attainment (7+ years) suffered more significantly from both increased years of life lost and mortality due to large diurnal temperature range, every 1 degrees C increase in DTR at a lag of 0-1 days was associated with an increase of 0.65 % (95 % CI: 0.08-1.23) and 1.42 years (0.88-3.72) for mortality and YLL	+	++
Yi, Wen et al.	2015	Age groups: 65-74; > 75 years. Relative risk of non-accidental mortality associated with cold temperature (11.1 A degrees C, 1st percentile of temperature) relative to 19.4 A degrees C (25th percentile of temperature) was 1.17 (95 % confidence interval (CI): 1.04, 1.29) for lags 0-13. The relative risk of non-accidental mortality associated with high temperature (31.5 A degrees C, 99th percentile of temperature) relative to 27.8 A degrees C (75th percentile of temperature) was 1.09 (95 % CI: 1.03, 1.17) for lags 0-3, people older than 75 years were the most vulnerable group to cold temperature, while people aged 65-74 were the most vulnerable group to hot temperature	+	++
Ruuhela, Reija et al.	2017	Age groups: <> 65, > 75 years. Temperature extremes: mean values of relative mortality in percentile-based categories of thermal indices: increase is strongest among those aged 75 years and older, but is somewhat elevated even among those younger than 65 years	+	++
Zanobetti, Antonella et al.	2012	Mortality hazard ratios ranged from 1.028 (95 % confidence interval, 1.013– 1.042) per 1 °C increase in summer temperature SD for persons with congestive heart failure to 1.040 (95 % confidence interval, 1.022–1.059) per 1 °C increase for those with diabetes. Associations were higher in elderly persons	+	++
Schaeffer, Laura et al.	2016	Two age groups: <> 65 years. Effect of heat was significant among people aged >75 years but not for those aged <75 years (RR=1.10 [95 % CI, 1.07; 1.14] vs RR=1.01 [95 %CI,0.98; 1.04]); effect of cold <75 years vs. >75 years(RR=1.04 [95 % CI, 1.01; 1.06] vs RR=1.02 [95 % CI, 1.00; 1.05]	+	++
Ding, Zan et al.	2015	Two age groups: <> 75 years. People ≥75 years old accounted for 57.02 % of all non-accidental deaths; Distribution of daily mortality from non-accidental causes <75/>75 years: 4.2 ± 2.1 /5.5 ± 2.6; RR (95 % CI) of extreme high DTR on daily non-accidental mortality <75/>75 years: 1.13 (0.46–2.73)/0.65 (0.29–1.46)	+	++
Lim, Youn-Hee et al.	2012	Two age groups: <> 75. Deaths among the elderly (>75 years), females, the less educated, and the non-hospital population were associated more strongly with DTR; 39 % were aged >75, 61 % had only completed 6 or fewer years of	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		schooling; change of mortality associated with a 1°C increase of DTR <75/>75 years: 0.4 (0.1,0.6)/0.6 (0.2,1.0) α=0.05 level		
Rocklov, Joacim et al.	2014	Age groups: <> 65 years. Effect on mortality by heat wave duration was higher for lower ages, in areas with lower wealth, for hospitalized patients younger than age 65; Odds ratio associated with heat wave duration (95 % CI) : 45-64, 65-79, >80: 1.060 (1.007, 1.116), 1.038 (1.005, 1.071), 1.017 (0.991, 1.043) resp.	-	++
Bai, Li et al.	2014	Two age groups: <> 65 years. Effect of heat on nonaccidental mortality was stronger among those over 65 compared with persons under 65 years of age: RR <65/≥65: 0.923 (0.501–1.699)/1.152 (0.788–1.385)	+	++
Rocklov, Joacim et al.	2008	Age: <65, 65–74, >74 years, with estimated increases of 0.5 % (n. s.), 1.5 % (n. s.) and 1.6 % (95 % CI 0.9–2.3) per ˚C, resp.; RRs for deaths from cardiovascular and respiratory causes were estimated to be 1.1 % (95 % CI 0.3–2.0) and 4.3 % (95 % CI 2.2–6.5) per ˚C, resp.	+	+
Xu, Wansu et al.	2013	Age > 65: Mortality all cause, Cardiovascular, Respiratory (%): male: 28.5, 7.1, 6.4; female: 18.2, 5.6, 3.0; hot days: No significant association was found between apparent temperature (AT) and mortality. The excess risks for every 1°C increase 0.07 % (95 % CI: 1.80 %, 1.69 %), 2.73 % (6.17 %, 0.84 %) and 0.97 % (3.78 %, 5.95 %) for all causes, CVD and RD mortality, resp; cold days: apparent temperature (AT) below 20.8°C was associated with an increase in mortality risk of 1.99 % (95 % CI: 0.64 %, 2.64 %) for all causes, 2.48 % (0.57 %, 4.36 %) for cardiovascular disease, and 3.19 % (0.59 %, 5.73 %) for respiratory disease for every 1°C decrease	0	++

Hochwasser/Überflutung	**Morbidität**	A00-B99 Bestimmte infektiöse und parasitäre Krankheiten	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Lau et al.	2016	significant differences in seroprevalence by age, gender, ethnicity, community types, and region: >60 years: 19.8%; 0–9 years: 8.2%; Poverty rate >40 %: OR 1.74 (1.31–2.31) p <0.001	+	+++

Hochwasser/Überflutung	**Morbidität**	A00-B99 Bestimmte infektiöse und parasitäre Krankheiten	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Liu et al.	2006	risk factors for PTSD included female sex (OR 1.12; 95% CI, 1.04 to 1.21), older age (age 18 to 59 years OR 2.28; 95%CI, 2.02 to 2.57, and age > 60 years OR 2.42; 95%CI, 2.05 to 2.85)	+	++

Stürme/Starkregen	**Gesundheitsinfrastruktur**	E87 Sonstige Störungen des Wasser- und Elektrolythaushaltes sowie des Säure-Basen-Gleichgewichts	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Swerdel et al.	2016	The rate of dehydration increased by about 79% in those over 65 years of age after Hurricane Sandy compared with the prior 4 years (RR: 1.75; 95% CI: 1.58, 2.02); no significant difference in the rate of hospitalization in those less than 65 years of age; males (RR: 1.63; 95% CI: 1.28, 2.07) and females (RR: 1.40; 95% CI: 1.29, 1.52) showed increased rates of hospitalization for dehydration after Sandy	+	+

Stürme/Starkregen	**Morbidität**	F00-F99 Psychische und Verhaltensstörungen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Sirey et al.	2017	aged ≥60 years: 14% reported clinically significant depressive symptoms (PHQ-9 ≥ 10) and 5.0% suicidal ideation; 17.5% of 60–74 Years screened positive for depression compared to 11.3% of older old adults ≥75 Years ($\chi2(1) = 11.59$, $P<0.001$); age and language were significantly associated with depression	+	+

Stürme/Starkregen	**Morbidität**	J00-J99 Krankheiten des Atmungssystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Tu & Chen	2017	adults 15-64 years: Children were the most vulnerable population for pneumonia in serious bare areas after Typhoon Morakot. >65: no statistical significance between prevalence changes for pneumonia and CLRD; children: the increased prevalence in pediatric pneumonia in serious bare areas was likely caused by Typhoon Morakot	-	+

Stürme/Starkregen	**Morbidität**	S00-Z98 Verletzungen, Vergiftungen und bestimmte andere Folgen äußerer Ursachen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Uscher-Pines et al.	2009	all aged > 65: Displaced victims had OR 1.53 (95% CI: 1.10–2.13) of sustaining a hip fracture in the year after the storm; prevalence of all injury types increased from the pre-Katrina to the post-Katrina year. Hip fracture prevalence increased from 0.65% to 0.81%, nonhip or other fractures from 3.5% to 4.2%, sprains or strains from 6.3% to 6.6%, and lacerations from 2.9% to 4.1%; increasing age (OR: 1.08, 95% CI: 1.06–1.11)	+	+

Stürme/Starkregen	**Mortalität**	S00-Z98 Verletzungen, Vergiftungen und bestimmte andere Folgen äußerer Ursachen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Seil et al.	2016	52 injury deaths: half of deaths were aged >65 years (48%); 77% of deaths were caused by injuries directly related to Hurricane Sandy	+	+

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B.3 Studien zu Vulnerabilität Älterer gegenüber Lärmbelastungen

B.3.1 Übersicht zu den Ergebnissen der Studien

Alltagslärm	**Morbidität**	F00-F99 Psychische und Verhaltensstörungen	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
van den Berg et al.	2014	Age groups: <> 65 years. Self-reported noise-related sleep disturbance is associated more strongly to noise annoyance than it is to noise exposure; Annoyance (A) and Sleep Disturbance (SD) is significantly related to age, the use of sleeping drugs, and living alone; Annoyance excess score (difference between the score on annoyance and the average sleep disturbance) is significantly greater for adults younger than 65 years	-	+++
Ristovska, G et al.	2009	Age groups: 41-50, 51-65 years. Most disturbed age group were individuals 51-65 years old, who were significantly more disturbed (p=0.010) than the age group of 41-50 years old; 32 % of subjects aged 51-65 years reported sleep disturbance; significant differences in sleep disturbances, between subjects at the age of 41-50 years and subjects at the age of 51-65 years for, Z = -2.5 and p = 0.01.	+	+++

Alltagslärm	**Morbidität**	H60-H95 Krankheiten des Ohres und des Warzenfortsatzes	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Rosenhall, U.	2003	Age: 70 years. Those reporting continuous tinnitus had a history of occupational noise exposure twice as often than those without this exposure. conclusion: no simple correlation between exposure to noise during the active years and tinnitus in old age	+	++++
Al-Swiahb, Jamil et al.	2016	Age groups: <40; 40-60; >60 years. Chronic tinnitus in older adults is subjectively louder, more annoying, and more distressing than that found in younger patients; The duration of symptoms was longest in patients above 60 years of age (P = 0.02, ANOVA); no difference in location or in the time of onset of tinnitus by age group; greatest number of patients with a catastrophic score (6 %) was found in the above 60-year age group	+	+++

Industrielärm	**Morbidität**	H60-H95 Krankheiten des Ohres und des Warzenfortsatzes	6

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Doi, Marcelo Yugi et al.	2015	significant association between the genotype and allele frequencies of the IL6 −174 gene and tinnitus among the elderly with history of exposure to occupational noise (P = 0.03); 35.8 % were heterozygous for IL6 (P > 0.05). Of these, 33.5 % reported noise exposure history, with 42.5 % having tinnitus	+	+++
Hederstierna, C. et al.	2016	Age: 70-75 years. No significant differences in hearing decline, at any frequency, for those aged 70-75 years between the noise-exposed (N= 62 men, 22 women) and the nonexposed groups	0	++++
Kovalova, M. et al.	2016	Age groups: <44; 44-60; 60-74; > 75 years. Females younger than 44 years and those older than 75 years were found to have no statistically significant differences at any pure-tone threshold audiometry frequency; in 60 to 74 age group, there were statistically significant differences at 3000 Hz and 4000 Hz. statistically significant differences in hearing loss at various frequencies in various male age groups	0	++
Morata, Thais C. et al.	2011	probability of hearing loss was greater among older participants as well as for males. No significant interaction was found for age or gender and the exposure variables.	+	++++
Girard, S. A. et al.	2014	relationship between severe noise-induced hearing loss (≥ 52.5 dB HL) and the occurrence of a fall (OR: 1.97, CI95 %: 1.001–3.876) p = 0.0495	+	+++
Melo, Juliana Jandre et al.	2012	Tinnitus was reported in 50 % of the cases, with tinnitus reported in 40 % of the elderly individuals with history of occupational noise exposure, and in 43 % of controls (elderly individuals without history of occupational noise exposure). no significant differences between tinnitus and the independent variables (exposure to noise, p = 0.0580; age, p = 0.8560; gender, p = 0.7544; hypertension, p = 0.3006; and diabetes, p = 0.4425)	0	+++

Industrielärm	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	3

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Yoshioka, Mayumi et al.	2010	The rate of people with atherosclerosis, either CA or RA, increased with age; significant effect of noise and a strong effect of age were demonstrated at all measured frequencies.	+	+++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Girard, S. A.	2014	Age: > 65 years (retired workers): Mean age at death for cardiovascular disease cases was 71.8 years; noise exposure (>36.5 years) (3rd tertile) was associated with an increased risk of cardiovascular disease death (OR 1.70; 95 % CI 1.10–2.62), as compared with shorter duration (<27 years) (first tertile). Moderate noise-induced hearing loss (2nd tertile) (OR 1.64; 95 % CI 1.04–2.6) and severe noise-induced hearing loss (3rd tertile) (OR 1.66; 95 % CI 1.06–2.60) were also associated with an increase in risk of cardiovascular disease death; risk of cardiovascular disease death increased progressively with the severity of hearing loss, with an OR of 1.66 (95 % CI 1.06–2.61)	+	+++
Poulsen, A. H. et al.	2018	Two age groups: <> 65 years. No association between wind turbines noise (WTN) and redemption of antihypertensive medication; HR 0.91 (95 % CI: 0.78–1.06) for outdoor WTN≥42dB(A) and HR 1.06 (CI: 0.83–1.35) for indoor LF WTN≥15dB(A) when compared to the reference WTN levels (<24dB(A) and<5dB (A), respectively); <65 years HR 0.81 (95 % CI: 0.67–0.98) and 0.94 (95 % CI: 0.68–1.30) for outdoor WTN≥42dB(A) and indoor WTN≥15dB (A), respectively; >65years the corresponding HRs were 1.17 (95 % CI: 0.90–1.52) and 1.28 (95 % CI: 0.87–1.88), We found indications of effect-modification by age, as for people above 65 years of age when redeeming antihypertensives, HRs seemed to increase at high exposures to outdoor WTN as well as at high exposures to indoor LF WTN, whereas for people below 65 years no or even a decreased HR was observed in the highest exposure groups	+	++

Verkehrslärm	**Morbidität**	F00-F99 Psychische und Verhaltensstörungen	16

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Linares, C. et al.	2017	Diurnal traffic noise may exacerbate the symptoms of dementia to the point of requiring emergency admission to hospital: Leqd (lag0): RR (95 % CI) 1.15 (1.11–1.20)	+	-
Schreckenberg, Dirk et al.	2010	Age groups: 50-59; 60-69; 70-79; > 80 years. 15.1 %: 50-59 years old, 19.3 % 60-69 %, 14.1 % 70ß79 and 6.8 % over 80. Age was non-linear related to aircraft noise annoyance. Annoyance is higher in group of middle-aged adults (40-60): F[2;2229]=11.14, p<0.001, np2= 0.01); older residents reported lower HQoL than younger	-	++
Oiamo, Tor H. et al.	2015	Age groups: <> 65 years. Older age group (65+) was overrepresented; Mental health and role emotional increased with age, while the middle age groups scored higher on social functioning, lower levels of functional health for older age groups. The effects of sex and age on annoyances were not significant	0	+++
van Renterghem, Timothy et al.	2012	Age > 50 years (52 %). Number of respondents (> 50): Q<10dBA= 23; 10dBA <Q< 20dBA= 16; Q>20dBA= 13; General noise annoyance independent of age class.	0	+++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Guite, H. F. et al.	2006	Age: 65-84 years: Better mental well-being was associated with that age group. Vital score 65-84 years: 17.1 % (n=41); mental score 65-84: 19.4 % (n=45)	0	+++
Carugno, Michele et al.	2018	Mean age: (56 years Zone A, reference zone): 48 years Zone B: 56: clear association between noise levels over 60 dBA, annoyance, and sleep disorders among adult residents, elevated adjusted annoyance scores (d&n): Zone A +2.7, Zone B: +4.0 (CI 90 %, p<0.001); severely annoyed: p<0.001=. Sleep disoders: 19.9 % reference zone, 29.9 % Zone A, 35.7 % Zone B (CI 90 %, p<0.001), no evidence of a relationship with blood pressure levels or prevalence of hypertension,	+	++
Schreckenberg, Dirk et al.	2010	Mean age: 51 years /reported health variables were not correlated with noise load. This was also true after adjusting to socio-demographic factors such as gender, age or social status	0	++
Méline, Julie et al.	2013	the annoyance due to road traffic was not associated with age OR 1,0	0	+++
Okokon, Enembe Oku et al.	2015	Mean age: 53 years, 40 % of study population 60-74 years old/noise annoyance: Reported by 17 %; road-traffic noise: reported health risk by 22 % /exhaust: reported health risk by 17 %. Knowledge of health risks from traffic noise: OR 2.04 (1.09-3.82) and noise sensitivity, OR 1.07 (1.00-1.14): positively associated with annoyance; Knowledge of health risks (p<0,045) and positive environmental attitudes (p<000) associated with higher noise sensitivity	+	++
Öhrström, E. et al.	2006	Mean age: 46 years. General: relationship between 1-5 point annoyance scale and sound levels (Laeq, 24h) was r=0.47 (p<0.01)/0-4 point scale category: r=0.56, p<0.01 /noise sensitivity - annoyance scales (p< 0.01): r=0.34 (0-4 point scale); r=0.36 (1-4point scale), r=0.37 (0-10 point scale) /sound levels were not related to noise sensitivity (r=0.03), clear evidence of the health benefits of having access to quiet, noise-shielded indoor and outdoor sections	+	++
Agarwal, Sheetal et al.	2011	Age groups: 45-65 years (30 %); > 65 years (10 %). 52 % males: irritation symptoms; 67.3 % males: headache; 48.6 % males: sleep loss; 46 % of respondents: hypertension; 34.7 % stress during work. 77.1 % females: disturbed by noise; 64 % females: severe irritation problems; 85 % females: headache; 78.3 % females: sleep loss; 55.4 % females: stress in daily life	+	+
Bluhm, G. et al.	2004	Age groups: 51-80 years: annoyed 31.4 %; sleep disturbance 19.3 % - no differences regarding reported annoyance due to sex, age	0	+++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Orban, E. et al.	2016	Age groups: 45-75 years. 35.7 % were exposed to high road traffic noise at their residence. 302 people with depressive symptoms (adjusted RR of 1.29, CI 95 %: 1.03, 1.62; Model 1) for exposure to > 55 vs. < 55 dB. People with reported insomnia: RR=1.62; 95 % CI: 1.10, 2.59 vs. RR=1.21; 95 % CI: 0.94, 1.57. People with less than 13 years of education: RR=1.43; 95 % CI: 1.10, 1.85 vs. 0.92; 95 % CI: 0.56, 1.53 for > 13 years	0	+
Hill, Erin M. et al.	2014	Mean age: 51 years, no concrete results for older people mentioned, age (B = −0.001, P = 0.464) and education (B = 0.007, P = 0.781), were not significant in predicting depression complaints	0	++
Sygna, Karin et al.	2014	Age groups: 51-65 years; > 66 years (16.3 %), sleep quality categories: poor: age 51-65 (15,5 %); >65: (17 %); medium, good	-	+++
Vandasova, Zdenka et al.	2016	Age > 60 years: 32 % in 2007; 53 % in 2013 /significantly associated with hypertension: traffic noise: OR 1.38, p=0.0053, (95 % CI); sleep disturbance by traffic and neighborhood noise: OR 1.64 (95 % CI); p=0.0084; all analyses were performed first separately for adults (age ≤60) and elderly people (age > 60.1). When the studied effects were similar for both age groups	+	+++

Verkehrslärm	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	15

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Rhee, Moo-Yong et al.	2008	Mean age 58 years (control) /60 years (helicopter) /58 years (fighter jet): higher prevalence of hypertension in people exposed to military aircraft noise (p=0.037); helicopter-noise exposed: higher prevalence (p=0.020); fighter-jet noise no higher prevalence (p=0.094) /prevalence of known hypertension: helicopter group: p=0.024, adjusted OR 1.62 (95 % CI, 1.02-2.59; 1.23 (95 % CI, 0.87-1.74) for fighter jet noise	0	++
Jarup, Lars et al.	2008	Age: 45-70 years /night-time aircraft noise: 10dB increase -> OR 1.14 (95 % CI, 1.01-1.29) /road-traffic noise: OR 1.54 (95 % CI, 0.99-2.40) in the highest exposure category (< 65dB; Ptrend=0.008) stronger in men; retired people (≥ 65 years of age): excess risk in women for a 10-dB increase in road traffic noise (OR = 1.63; 95 % CI, 1.21–2,20), but no significant excess risks for daytime (OR = 1.18; 95 % CI, 0.82–1,71) or night-time (OR = 0.91; 95 % CI, 0.63–1.34) aircraft noise There were no significant risks in men for any of the noise exposure variables (road traffic noise: OR = 1.03; 95 % CI, 0.77–1.38; daytime aircraft noise: OR = 0.96; 95 % CI, 0.65–1.43; nighttime aircraft noise: OR = 1.10; 95 % CI, 0.73–1.67).	0	+++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
zur Nieden, Anja et al.	2017	Mean age: 49 years; SD=12.2 non-significant tendency of association of blood pressure with nocturnal sound levels (b=0.10 (mmHg x dB-1); 95 % CI -0.02;0.21); adjusted: b=0.11 (mmHg x dB-1); 95 % CI 0.02; 0.20	0	++
Andrew, W. et al.	2013	Age: > 65 years: An 10dB higher noise exposure implies a 3.5 % higher (95 % CI 0.2 % - 7.0 %) CVD- hospital admission rate for older people.	+	-
Schmidt, Frank et al.	2015	Mean age: 61 years: mean sound pressure Leq was 46.9+-2.9dB; 39.2 +-3.1dB in the control nights /sleep quality reduced by noise from 5.8 +-2.0 to 3.7 +- 2.2 (p<0.0001) /FMD was significantly reduced from 9.6 +- 4.3 to 7.9 +- 3.7 %; p<0.001 /systolic blood pressure was increased (from 129.5 +- 16.5 to 133.5 +-17.9mmHg; p= 0.030)	+	+++
Roswall, Nina et al.	2015	Age: 50-64 years - 10dB higher road traffic noise implies a 0.14 lower mental component summary score (95 % CI -0.26, -0.01) /after adjustment: -0.08 (95 % CI -0,20, 0.04)	+	++
Banerjee, Dibyendu et al.	2014	Mean age of study population: 41 years; significant OR of 1.66 (1.43-1.91) was observed for all age groups. Prevalence of hypertension highest in the age group 65-76 (95 % CI) , females in higher age groups were more at risk (1.80 (1.45–2.23) than males (1.50 (1.24–1.82))	+	++
Bodin, Theo et al.	2009	Age: 53-69 years; mean age: 61 years; Age 40-59: effects of road noise exposures were seen in the 60-64 and > 64 dB(A) categories. OR (95 % CI) 1.30 (1.05.1.61) 2.03 (1.28-3.24); There was no clear association between road traffic noise and prevalence of hypertension in the oldest age group (60-80 years old)	0	+++
Fuks, Kateryna et al.	2011	Age: 45-75 years; Hypertension (57 %) and use of antihypertensive medication (36.1 %) were highly prevalent in the elderly population	+	++
Sørensen, Mette et al.	2011	Age: > 64 years. Significant interaction with age (P<0.001); strong association between road traffic noise and stroke among cases (IRR: 1.27, 95 % CI: 1.13-1.43)	+	+
Azuma, K. et al.	2017	Age: > 65 years; OR for construction noise at nighttime: 1.12 (1.06-1.19) with disturbances in pulse, 1.21 (1.08-1.35) in acute impaired tongue movement, 1.25 (1.15-1.36) in limb paralysis, and 1.19 (1.12-1.28) in foot pain or numbness during walking. Automobile, construction, railway, and aircraft noise were significantly associated with more CVD-related symptoms at nighttime than at daytime.	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Niemann, H. et al.	2006	No statistical association between chronic annoyance (traffic noise) and an increased risk for the cardiovascular system, respiratory and neuro-psychic of elderly adults: CV-symptoms: ptrend: 0.167; OR (95 % CI)0.97: moderately; 1.32: severely /for hypertension: ptrend: 0.204; moderately: 1.12; severely: 1.24; /for heart attack: ptrend: 0.618; moderately: 0.83; severely: 0.93 /effect of chronic annoyance by traffic noise was visible in the locomotor system: Arth. symptoms: OR (95 % CI)moderately: 1.22, severely: 1.93, ptrend: 0.001 /Arthrosis: ptrend=0.000 OD moderately: 1.16; severely: 2.32 /allergy: ptrend: 0.084; OR moderately: 1.23; severely: 1.56; no association between a chronic annoyance by neighbourhood noise and increased risks for the cardiovascular system	0	+++
van Kamp, Irene et al.	2009	Age: > 60 years; No indication for a higher vulnerability to noise in terms of annoyance and sleep disturbance	0	++
Sørensen, Mette et al.	2014	Age: 50-64 years; a higher mean annual exposure of 10 qg/m3 NO2 and 10 dB road traffic noise at home was associated with ischemic stroke with IRR: 1.11 (95 % CI: 1.03,1.20) and 1.16 (95 % CI: 1.07, 1.24) in single-exposure models. Two-exposure models: road traffic noise: IRR: 1.15, and not NO2 (IRR: 1.02= was associated with ischemic stroke. Strongest association: Combination high noise and high NO" (IRR=1.28; 95 % CI=1.09-1.52)	+	++
Bodin, Theo et al.	2016	Age groups: (relevant) 50-59: 60-69: 70-79; > 80 years, median age: 49 years (2000); 53 years (2005); 56 years (2010), no specific risk of myocardial infarction for older people	0	+++

Verkehrslärm	**Morbidität**	Diverse	3

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Dratva, Julia et al.	2010	Age: > 49 years. 13 % high annoyed; all SF-36 scores showed a significant negative association with noise annoyance; age, with significantly decreased odds of high noise annoyance in older participants (>49 years)	-	++
Carrier, M. et al.	2016	Age: > 65 years. The relationship between the road noise level and the proportion of people > 65 is slightly negative (-0.015, p= 0.026); None of the differences in road noise between the first and the four other quintiles are significant (p=0.836; 0.535; 0.738; 0.202)	0	-
Halonen, Jaana I. et al.	2015	Age > 75 years: RR: 1.09 (95 % CI: 1.04-1.14) for daytime traffic noise associated with hospital admissions for stroke; nighttime-noise - stroke mortality: RR 1.13 %, 95 % CI: 0.98-1.30)	+	+

Verkehrslärm	**Mortalität**	C00-D48 Neubildungen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Roswall, Nina et al.	2016	Mean age: 68 years (breast cancer death), 69 (all-cause mortality death). no association between residential road traffic noise and breast cancer survival: no association between time-weighted averages of residential road traffic noise 1-, 3- or 5-years before death, or over the entire follow-up period, and overall or breast cancer-specific mortality Mean age at death for breast cancer: 68.6 (57.5-78.1); mean age of death for all-cause mortality: 69.8 (59.0-79.5)	0	+

Verkehrslärm	**Mortalität**	I00-I99 Krankheiten des Kreislaufsystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Hart, Jaime E. et al.	2014	living within 50 m of major roadway: elevated risk of SCD (HR=1.56; 95 % CO: 1.18-2.05) /after control: HR=1.38; 95 % CI: 1.04-1.82) /equivalent adjusted HRs for nonfatal myocardial infarction and fatal CHD: 1.08 (95 % CI: 0.96-1.23) and 1.24 (95 % CI: 1.03-1.50)	+	+

Verkehrslärm	**Mortalität**	J00-J99 Krankheiten des Atmungssystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Tobías, Aurelio et al.	2014	Age: > 65 years. Daily death rate: 9.5 (0-32); average daytime noise level (65 dB(a) (62.1-71.0); noise levels: low correlation with chemical air pollutants (r=0.28 and r=0.01 for NO2 and PM2.5) /risk increase (respiratory mortality in > 65 years): p<0.05; 6.5 % increase (95 % CI 0.8-12.2 %) /independent effect of noise found for PM2.5: 3.3 % 95 % CI 0.3-6.2 % for an Iqr 10 qg/m3 and NO2: 0.9 % 95 % CI 0.1-1.6 % for an IQR of 5 qg/m3, both p< 0.05	+	-

Verkehrslärm	**Mortalität**	Diverse	3

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Barceló, M. et al.	2016	Age > 65 years (17.28 %) Traffic noise was associated with MI-mortality along with Diabetes Type 2 (men) (OR: ca. 1.02) and mortality hypertension (women) OR: ca. 1.01); No statistically significant associations were found for men < 65 years; In men aged >65 years the noise levels in the evening lost significance and in men aged 75 years and older only daytime noise levels were statistically significantly associated (90 % CI)	0	+
Recio, Alberto et al.	2016	Age > 65 years: increase mortality rate(IHD, MI, cerebrovascular disease, pneumonia, COPD): 1dBA increase in (max. nocturnal noise): 2.9 % (95 % CI 1.1, 6.1 %), 2.4 % (95 % CI 0.1, 4.8 %), 3.0 % (95 % CI 0.2, 5.8 %) and 4.0 % (95 % CI 1.0, 7.0 %) /diabetes: 1 dBA increase: increased mortality rate of 11 % (95 % CI, 4.0, 19 %) /age < 65: 1dBA increase: increased mortality (IHD, MI): 11 % (95 % CI 4.2, 18 %)	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Tobias, Aurelio et al.	2015	Reduction of 1dB in LeqD: avoidable annual mortality of 284 (31523) cardiovascular- and 184 (0,190) respiratory-related deaths in the study population	+	+

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B.4 Studien zur Vulnerabilität Älterer gegenüber Luftbelastungen

B.4.1 Übersicht zu den Ergebnissen

Bioaerosole	**Morbidität**	A00-B99 Bestimmte infektiöse und parasitäre Krankheiten	3

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Bauer, M. et al.	2008	Age: 46-102 years; mean age: 81; SD = 10,; 828 subjects; association between Legionella (bacteria) contaminated water (shower --> aerosol) and pontiac fever symptoms; Risk of Pontiac fever 75–90 vs <75 years: woman 0.94 (0.31 to 2.82) (p=1), men 1.34 (0.25 to 7.14) (p=1); 2/3 women, mean age 82 years; incidence density 0.11 case/person-year (95 % CI 0.07-0.15); strong relation between corticotherapy and pontiac fever (relative risk 4.0, CI 1.1-14.9)	0	++
Soltani, M. et al.	2015	Specimens from 79 patients (56.4 %) were positive for onychomycosis. Females were more infected than males. highest prevalence was seen in patients with age varying from 41 to 60 years (40.7 %) and lowest prevalence in participants with age varying from 0 to 20 years (6.4 %).	-	++
Yoo, J. Y. et al.	2014	Age > 65 years: 629 elderly patients represented 22.1 % of all onychomycosis patients. The ratio of male to female was 1.01:1; prevalence of onychomycosis was determined in the age groups: 65~69 years (n=246, 39.1 %); 70~74 years (n=197, 31.3 %); 75~79 years (n=120, 20.0 %); 80~84 years (n=48, 7.7 %); 85~89	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		years (n=14, 2.2 %); over 90 years (n=4, 0.7 %).Associated systemic diseases were found in 327 (52.0 %) cases; The most common cause of onychomycosis in the elderly was Trichophyton rubrum		

Benzol	**Mortalität**	C00-D48 Neubildungen	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Micheli, Andrea et al.	2014	Age: 25-74 years (43 %), > 75 years (55 %), 177 subjects, ; No increased risk of HM death for males and females combined living close to the refinery was found; risk of hematological malignancies (HM) from benzene depending on proximity to petrochemical refinery; retired-homemaker-unemployed category had higher risk of HM and leukemia plus non-Hodgkin lymphoma with increasing proximity, HM OR 2.41 (95 % CI 0.98-5.89), leukemia and non-Hodgkin lymphoma OR 3.44 (95 % CI 1.04-11.37)	-	++
Richardson, David B.	2008	Mean age at entry: 41 years, mean age at exit 62 years; 1845 (17 cases, 1828 noncases) subjects; cumulative exposure to benzene increases RR in older ages (>45) --> >500 ppm-year RR 13.9 (95 % CI 0.7-116.1); leukemia mortality RR 1.19 (1.10-1.29) if time since exposure <10 years; Benzene exposures accrued at younger ages exhibited little evidence of association with leukemia	+	++

Ozon	**Morbidität**	C00-D48 Neubildungen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Vieira, Verónica M. et al.	2017	Median age: 65 years; 11765 subjects; association between air pollution and ovarian cancer survival; ozone HR 1.14 (95 % CI 1.07-1.26)	+	+

Schwermetalle	**Morbidität**	C00-D48 Neubildungen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Adams, Scott V. et al.	2016	Age: 50-79 years; 508 subjects (229 over 65 years old); association between urinary cadmium and breast cancer; no association found	0	++

Schwermetalle	**Mortalität**	C00-D48 Neubildungen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
García-Esquinas, Esther et al.	2014	Age: 45-74 years, mean age 56, cadmium exposure and cancer mortality; low-to-moderate Cd exposure was prospectively associated with total cancer mortality and with mortality from cancers of the lung and pancreas; older people, those with lower education, current smokers and never drinkers had higher cancer mortality	+	+

Stickstoffdioxid	**Morbidität**	C00-D48 Neubildungen	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Bidoli, Ettore et al.	2015	Two age groups: <> 75 years; significantly risks of lung cancer <75 years (RR = 1.35 vs. urban area; 95 % CI: 1.03–1.77); >75 years or older, no significant RRs were observed; risk of lung cancer tended to be lower in the outlying area in both men (RR = 0.87; 95 % CI: 0.72–0.98) and women (RR = 0.74; 95 % CI: 0.62–0.88)	-	++
Parent, Marie-Elise et al.	2013	Age < 75 years (men): increased risk of prostate cancer for NO2: OR 5ppb (adjusted for personal factors) was 1.44 (95 % CI 1.21 to 1.73)	+	+++

Feinstaub	**Mortalität**	C00-D48 Neubildungen	9

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Chen, Shu-Chen et al.	2008	Age: mean 63.7 /No difference in age along the use of mosquito coil (exposure). More frequent in lung cancer patients than controls (38.1 % vs. 17.8 %, p<0.01)	+	++
Pan, Wen-Chi et al.	2015	Age groups: 30-39; 40-49; 50-59; 60-65. Long-term exposure to PM2.5 increased the risk for liver cancer. Participants exposed to higher PM2.5 levels were consistently older and had higher prevalence of HBsAg seropositivity as well as alcohol consumption	+	+
Myneni, A. A. et al.	2013	Age groups: < 45; 45-55; 55-65; > 65 years old. GG genotype of TERT was positively associated with lung cancer (OR 1.47, 95 % CI: 1.00-2.16) association stronger in people > 60	+	++
Turner, Michelle C. et al.	2011	Age categories: < 70; 70-79; > 80 years old, most participants were between 50 and 69 years old. HRs for the different age groups (95 % CI): > 65: 1.22 (0.87-1.73), p=1. Attained age: > 70: 1.37 (0.91-2.07); 70-79: 1.14 (0.80-1.63); > 80: 1.33 (0.96-1.84) p=0.77	+	++
Brenner, Darren R. et al.	2010	Age: 20-84; People > 50 years old had a significant increase in lung cancer risk (OR4.2, 95 % CI 1.0-10.9)	+	++
Collarile, P. et al.	2017	Two age groups: < >75 years; no significant associations for people under 75. women > 75: increased risk of lung and bladder cancers related to a high exposure to benzene (IRR for	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		highest vs. Lowest tertile: 2.00 for lung cancer and 1.94 for bladder cancer) and NO2: IRR: 1.72 for lung cancer; and 1.94 for bladder cancer		
Bidoli, Ettore et al.	2016	Age groups: <> 65 years; Significant risk within 25m of national major roads for 65+: RR=1.15, 95 % CI, 1.04-1.23 in men and RR=1.77, 95 % CI, 1.44-2.18 in women	+	+
Barone-Adesi, Francesco et al.	2012	Mean age: 39 at beginning, 57 at the end. Absolut risks of lung cancer death before 70 years for men: 18 % women: 20 % (using smoky coal). Lung cancer alone: 40 % of deaths before 60 years	-	++
Guo, Yuming et al.	2016	Three age groups: 30-65; 65-75; > 75: The relative risks of lung cancer incidence related to a 10 µg/m3 increase in 2-years average PM2.5: 1.1111 (95 %CI, 1.077; 1.146) for people > 75	+	+

Feinstaub	**Morbidität**	C00-D48 Neubildungen	9

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Li, Hao et al.	2013	Two age groups: 35-59; 60-84; Increased mortality rates for lung cancer: 3.55 males, 3.35 females. Age group with the highest mortality rate shifted to older ages. Mortality of lung cancer increases with age. Mortality rate 60-84 (exposed to air pollution) were 324.66 per 100.000 for males and 159.32 per 100.000 for females	+	+
Li, Bingyu et al.	2018	Age groups: > 40; 55-60; 75-80 /Mortality is higher in men than in women and increasing with age. The highest mortality rate was observed in the age group 75-80	+	+

Schwermetalle	**Morbidität**	E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Tsaih, Shirng-Wern et al.	2004	Mean age: 66 years; 448 subjects; association between lead, diabetes, hypertension and renal function; interaction blood lead and tibia lead with diabetes significantly increases serum creatinine; tibia lead interaction with hypertension change serum creatinine; -> decline of renal function among middle-age and elderly individuals appears to depend on both long-term lead stores and circulating lead, being stronger among diabetics and hypertensives	+	++

Feinstaub	**Gesundheitsinfrastruktur**	E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Song, J. et al.	2018	Two age groups: 35-64; > 65 /Stronger association between PM2.5, PM10 and CO concentrations associated in the male and elderly > 65. 51.6 % admissions accounted for the elders. PM2.5: 0.56 (0.22-0.90); PM10: 0.37 (0.12-0.62); NO2: 1.68 (0.62-2.74); CO: 0.04 (0.02-0.07) meaning a 10 µg/m3 increase impacting on T2DM hospital admissions	+	+
Sun, S.et al.	2016	Mean age: 76 /PM10 was associated with emergency hospital admissions for T2DM at lag2 with ER(%) of 2.42 (95 % CI, 0.30, 4.53) per IQR (41.5 µg/m3). EC, OC, NO3, NI, K+ were significantly associated with T2DM hospitalizations at certain lags from lag 0 to lag 3	+	+

Feinstaub	**Morbidität**	E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten	6

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Wallwork, Rachel S. et al.	2016	Mean age: 70 /1 µg/m3 increase in mean annual PM2.5 was associated with a higher risk of fasting blood glucose level (HR=1.20. 95 % CI: 1.03, 1.39) and hypertriglyderidemia (HR=1.14, 95 % CI: 1.00, 1.30. 1 °C increase in mean annual temperature was associated with a higher risk of developing elevated fasting blood glucose (HR=1.33, 95 % CI, 1.14, 1.56)	+	+
Liu, Cong et al.	2016	Mean age: 59 years; Increments of fasting glucose and HbA1c were 20-82 % higher among older people	+	++
Pettit, Ashley P. et al.	2015	Mean age: 61 (cases); 57 (controls) /Adverse vascular effects of a two hour traffic exposure observed. A decreased vascular reactivity response following a car ride could be seen.	+	+++
Kim, Jin Hee et al.	2012	Mean age: 70 /IQR increases in PM10, O3 and NO2 were significantly associated with IR indices, depending on the lag period	+	+
Park, Sung Kyun et al.	2015	Mean age: 64.3 /significant associations of prevalent DM with PM2.5 (OR=1.09, 95 % CI: 1.00, 1.17) and NO (OR=1.18, 95 % CI, 1.01, 1.38) per each interquartile-range increase (2.43 µg/m3 and 47.1 ppb, respectively)	+	+
Dijkema, Marieke B. et al.	2011	various age groups: 50->65 years, 43 % over 60 years; 8018 subjects; traffic-related air pollution and type 2 diabetes; no consistent associations between type 2 diabetes and exposure to traffic-related air pollution was found	0	++

Feinstaub	**Mortalität**	E00-E90 Endokrine, Ernährungs- und Stoffwechselkrankheiten	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Huang, Wen-Hung et al.	2013	Age: > 65; mean age: 72 /Patients in the basin group had a higher incidence of combined protein-energy wasting and inflammation than those in the around basin group. Mortality	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		was significantly associated with an age of 80 or older and peripheral vascular disease		
Brook, Robert D. et al.	2013	Age: 25->70 years; 2145400 subjects; air pollution and mortality from diabetes; PM2.5 is related to an increased risk of mortality attributable to diabetes	+	++

Feinstaub	**Morbidität**	F00-F99 Psychische und Verhaltensstörungen	13

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Sun, Rongjun et al.	2008	Age: 65-79; Air pollution increase in areas with high GDP is associated with more difficulties in activities of daily living: OR=1.41, 95 % CI: 1.09, 1.83; instrumental activities of daily living LC=0.98,95 % CI: 0.58, 1.37 and cognitive function_ LC=2.67, 95 % CI: 1.97, 3.36. As well as a higher level of self-rated poor health: OR: 2.20, 95 % CI: 1.68, 2.86	+	+
Wang, Yi et al.	2014	Mean age: 78 /No evidence for a positive association between long-term traffic exposure and depression.	0	+
Weinreich, Gerhard et al.	2015	Age: 50-84; mean age: 63 /the mean±SD AHI was 11.2±11.4 events·h−1. Over all seasons, an interquartile range increase in temperature (8.6°C) and ozone (39.5 µg·m−3) was associated with a 10.2 % (95 % CI 1.2–20.0 %) and 10.1 % (95 % CI 2.0–18.9 %) increase in AHI	+	+
Tallon, Lindsay A. et al.	2017	Age: 57-85; mean age: 72 /IQR increases in 1 to 7 years PM2.5 exposures were associated with a 0.22 (95 % CI: -0.44, 0.01) to a 0.25 (95 % CI: -0.43, -0.06) point decrease in CCFM scores, while NO2 exposures were equivalent to aging 1.9 years	+	+
Kim, Jayeun et al.	2017	Age groups: 19-39; 40-59; 60-74; 75+ /OR (self-rated stress level) people 60-74 years old: 0.78 (0.72-0.84); 75+ age: 0.67 (0.59-0.77) /Depressive Symptom Experience: 60-74: 1.06 (0.94-1.20); 0.82 (0.68-0.98) PM10 was associated with poorer SRS [OR 1.02, 95 % CI 1.00–1.04] by 10 µg/m3 increases.	+	++
Ailshire, Jennifer A. et al.	2014	Age: >55 years, 51 % oder 65 years; 780 subjects; PM and cognitive function in older adults; exposure to PM2.5 negatively affect the cognitive function among older adults	+	+
Wellenius, Gregory A. et al.	2012	Age: > 65, mean age: 78 / increased risk for older people was observed. For people < 77: OR: 1.34; 95 % CI (1.01, 1.76)	+	+
Kioumourtzoglou, Marianthi-Anna et al.	2017	Age: mean 66.6 years; 41844 subjects; air pollution and depression; association between PM2.5 and ozone with antidepressant use found	+	+
Power, Melinda C. et al.	2015	Mean age: 70 years /Prevalence of high anxiety symptoms: 15 %; increase in OR of high anxiety symptoms with a higher	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		exposure to PM2.5 (10µg/m3 one month): 1.12, 95 % CI: 1.06-1.19; 12 months: 1.15, 1.06-1.26		
Oudin, Anna et al.	2016	Age: 35-85 years; air pollution from traffic might be an important risk factor for vascular dementia and Alzheimer's disease	+	++
Tonne, Cathryn et al.	2014	Age: mean 66 years; air pollution associated with some measures of cognitive function, as well as decline over time in cognition	+	+
Lim, Youn-Hee et al.	2012	Age: 60-87 years, median 70 years; 537 subjects; air pollution and depression; increases in PM10, NO2 and O3 may increase depressive symptoms among elderly	+	+

Schwermetalle	**Morbidität**	F00-F99 Psychische und Verhaltensstörungen	4

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Krieg, Edward F. et al.	2010	Age: > 60 years (38 %); 4734 subjects; lead exposure and cognitive function under different genotypes; relationship between serum homocysteine and blood lead concentrations varied by genotype in children (12-16 years) and adults over 60 years old; > 60 years: performance on the word and story recall tests was not related to the blood lead concentration	0	++
Grashow, Rachel et al.	2013	Age: > 70 years (78 %); 51 subjects; lead exposure and acoustic startle reflex (ASR) - a simple form of associative learning in the brain; exploration suggests that lead exposure interferes with specific neural mechanisms of learning	+	+
Rajan, Pradeep et al.	2007	Mean age: 67 years; 1075 subjects; lead exposure and psychiatric symptoms modified by ALAD polymorphism; tibia lead associated with 21 % higher odds of somatization, patella lead corresponds to a 23 % increase in the odds of global distress, blood lead associated with 14 % higher odds of hostility, other analyses showed nonsignificant association of lead with psychiatric symptoms	+	+
van Wijngaarden, Edwin et al.	2009	Age: 55-67 years; mean age: 61; 47 subjects; lead exposure and memory impairment; tibial lead associated with lower performance levels on delayed match-to-sample and paired associates learning; association of higher calcaneal lead levels with increasing memory impairment; additional adjustment for history of hypertension reduced the strength of this association	+	+

Stickstoffdioxid	**Morbidität**	F00-F99 Psychische und Verhaltensstörungen	3

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Hwang, Myung-Jae et al.	2018	various age groups: highest odds ratio (OR) for subjective stress level for 30–64 years (men: 2.91; 95 % CI, 2.12 to 4.01; women: 1.82; 95 % CI, 1.32 to 2.51); >65: increasing OR with increasing	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		concentration; Men showed higher ORs than women in all strata.		
Tian, T. et al.	2015	Age: > 60 years: 27.8 % had psychological disorders; Air pollution significantly influenced the mental health: average CES-D score of all samples is 8.09, critical value of depression ≧10; CES-D score of urban old people is significantly lower than that of rural old people	+	++
Wang, Qing; Yang, Zhiming	2018	Age: > 60 years, various age groups: CES-D score: 7 and 28 [average 11.623 (SD = 4.664)]: An 1 % increase in SO2 and total suspended particulate emission intensities was associated with depressive symptoms scores that were 1.266 (SE = 0.107, P < 0.001, 95 % CI 1.057–1.475) and 1.318 (SE = 0.082, P < 0.001, 95 % CI 1.157–1.480) higher, resp.; Association of air pollution intensity and depressive symptoms for chronic symptoms, correlation coefficient: 60-69: 0.148 (n.s.) >70: – 0.396 (P < 0.01)	+	++

Schwermetalle	**Morbidität**	G00-G99 Krankheiten des Nervensystems	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Coon, Steven et al.	2006	Age: > 60 years (85.5 %); 121 subjects; lead exposure and Parkinsons disease (PD); risk for PD 2.27 (95 %, 1.13-4.55) highest quartile compared to lowest quartile	0	+++
Weisskopf, Marc G. et al.	2010	Mean age: 66 years; 330 subjects; exposure of lead and Parkinsons disease (PD); tibia lead OR for PD in highest quartile was 3.21 (95 % CI 1.11-5.93); no association with patella bone lead	+	+++

Feinstaub	**Morbidität**	G00-G99 Krankheiten des Nervensystems	6

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Palacios, Natalia et al.	2017	Mean age: 56-57 /no significant associations between PM exposure and PD risk. Comparison of the top to the bottom quintile of PM exposure was 0.85 (95 % CO: 0.63, 1.15) for PM10, 0.97 % (95 % CI: 0.72, 1.32) for PM2.5 and 0.88 (95 % CI: 0.64, 1.22)	0	+
Wilker, Elissa H. et al.	2015	Age: >60 years; 943 subjects; long-term exposure to PM and brain structure; PM2.5 associated with smaller total cerebral brain volume, a marker of age-associated brain atrophy, and with higher odds of covert brain infarcts	+	+
Chen, Jiu-Chiuan et al.	2015	Age: 71-89 /women with greater PM2.5 exposures had significantly smaller WM, but not GM volumes. For each inter-quartile increment (3.49 µg/m3) f PM2.5 exposure, the average WM volume (95 % CI) was 6.23 (3.72-8.74) cm^3 in the total brain and 4.47 (2.27-6.67) cm^3 lower in the association areas.	+	+++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Kirrane, Ellen F. et al.	2015	Age groups: 12-50; 51-60; 61-70; 71-92 /positive associations of Parkinson's disease with ozone (OR=1.39; 95 % CI: 0.98, 1.98) and PM (OR=1.34; 95 % CI: 0.93, 1.93)	0	++
Lee, Pei-Chen et al.	2016	Age: >35 years, mean 62 years; 1828 subjects; air pollution and inflammation in Parkinson's related to gene environment; long-term exposure to NO2 increased PD risk; no significant gene-environment interactions were found	+	++
Chen, Chiu-Ying et al.	2017	Age: >40 years, 86.7 % of people diagnosed with PD (n=1060) over 60 years; 54524 subjects; air pollution and Parkinson's disease; from all the investigated chemicals only PM10 significantly affected the incidence of PD; additionally comorbid conditions such as dementia, stroke, depression, head injury, sleep disorder and hypertension also significantly increased the risk for PD	+	+
Lee, Hyewon et al.	2017	Three age groups: <64; 65-74; >75 /A unit increase in 8-day moving average of concentrations was significantly associated with PD aggravation. The association was consistent for PM2.5 (OR[95 % CI]: 1.61 [1.14-2.29] per 10 µg/m3), NO2 (2.35 [1.39-3.97] per 10 ppb), SO2 (1.54 [1.11-2.14] per 1ppb), and CO (1.46 [1.05-2.04] per 0.1 ppb). Stronger for people between 65 and 74 years.	+	+
Weng, Cheng-Hao et al.	2017	Mean age: 57 /PM2.5 levels and PM2.5 excessing days were positively correlated with CTS.	+	++

Feinstaub	**Gesundheitsinfrastruktur**	G00-G99 Krankheiten des Nervensystems	1

AutorInnen	**Jahr**	**Ergebnisse**	**Effekt**	**Qualität**
Kioumourtzoglou, Marianthi-Anna et al.	2016	Age: >65 years; 9817806 subjects; air pollution and neurological hospital admissions; exposure significantly associated with time to first hospitalization for dementia, Alzheimer's disease and Parkinson's disease	+	

Stickstoffdioxid	**Morbidität**	H00-H59 Krankheiten des Auges und der Augenanhangsgebilde	1

AutorInnen	**Jahr**	**Ergebnisse**	**Effekt**	**Qualität**
Chiang, Chun-Chi et al.	2012	Age: > 64 years, and children have higher risk of conjunctivitis: RR akut:2.63* (2.58-2.67) chronic: 4.04* (4.01-4.08); acute: 2.16* (2.13-2.19) chronic: 2.79* (2.77-2.81) resp.; Females were also more prone to elevated risk 1.16* (1.15--1.18), 1.51* (1.49--1.51)	+	+

Schwermetalle	**Morbidität**	H60-H95 Krankheiten des Ohres und des Warzenfortsatzes	1

AutorInnen	**Jahr**	**Ergebnisse**	**Effekt**	**Qualität**
Huh, Da-An et al.	2016	Age: 10-87 years, no more details; 7596 subjects; association between earphone use and environmental lead exposure on hearing loss	0	++

Feinstaub	**Morbidität**	L00-L99 Krankheiten der Haut und der Unterhaut	1

AutorInnen	**Jahr**	**Ergebnisse**	**Effekt**	**Qualität**
Hüls, Anke et al.	2016	Age: mean 73.5 years; strongest association between NO2 and lentigines was on the cheeks of women older than 50 years	+	++
Vierkoetter, Andrea et al.	2010	Age: 70-80 /Mean age: 74 /Air pollution exposure was significantly correlated to extrinsic skin aging signs, in particular to pigment spots and less pronounced to wrinkles. AN increase in soot and particles from traffic (per 475kg/a/km2) was associated with 20 % more pigment sports on forehead and cheeks.	+	+

Feinstaub	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	37

AutorInnen	**Jahr**	**Ergebnisse**	**Effekt**	**Qualität**
Xie, Juan et al.	2014	Age > 65: More ED visits; 10 µg/m3 increase in pollutants goes along with increase in ED visits (all 95 % CI): PM10: > 65 years: 2.97 (2.14, 3.80); SO2: 0.37 (0.04, 0.70); NO2: 4.13 (2.92, 5.34); male: PM10 1.30 (0.53, 2.07), SO2 1.20 (-0.04, 2.43),	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		NO2 1.94 (1.05, 2.84); female: PM10 0.90 (0.13, 1.67), SO2 0.90 (-0.14, 1.93), NO2 0.94 (0.28, 1.60)		
Xu, Anyang et al.	2017	Age > 40; age groups: 41-65, 66-85, > 85; 51.1 % 65-85 years /positive effect of PM10 on hospitalizations was observed in each group except > 85 years	+	+
Wang, Xiaoming et al.	2015	Two age groups: < > 65 years: susceptible to increased NO2 concentrations: Elderly and elders with hypertension, elevated risk of hospitalization for NSTEMI for those	+	+
Nascimento, L. F. C.	2011	Age: > 60 /Exposure to PM was significantly associated with hospitalization for cardiovascular disease 3 days after exposure (RR=1.006; 95 % CI= 1.000 -1.010) and an increase of 16 µg/m3 was associated with a 10 % increase in risk of hospitalization	+	
Fung, K. Y. et al.	2005	Two age groups: <> 65 /SO2 had the strongest effect on cardiac hospitalization: Daily admission: 2.6 % for SO2 (95 % CI, 0.5-6.4), 4.0 % for 2-day mean level (95 % CI: 0.1-6.9), and 5.6 (95 % CI: 1.5-9.9)	+	+
Wellenius, G. A et al.	2005	Age: > 65 /ischemic stroke: increase in PM10: 1.03 % (95 % CI, 0.04 % - 2.04 % increase in admissions on the same day. Similar for CO, NO2 and SO2	+	
Ukëhaxhaj, Antigona et al.	2013	Age groups: 20-29; 30-39; 40-49; 50-59; 60-69; +70 /higher risk of cardiovascular hospital morbidity for people > 69 years for ll pollutants except PM10	+	+
Vahedian, Mostafa et al.	2017	Age groups: 0-18; 19-60; > 60 /The effect of CO and NO2 was strongest in the elderly. Age group > 60 were more susceptible to air pollution with regard to cardiovascular hospital admissions	+	+
Zhao, Ang et al.	2014	Two age groups: <> 65 years, mean age: 78 /Stronger associations for outpatient arrythmia visits in older people (> 65). 10µg/m3 increase in pollutant concentrations for > 65 (95 % CI): PM10: 0.95 (0.78, 1.13); NO2: 3.52 (3.03, 4.00); SO2: 4.15 (3.42, 4.89)	+	+
Zhang, Qian et al.	2016	Two age groups: <> 65, 58.17 % were > 65 years old /Each increase of 10 µg/m3 PM2.5 was associated with an increased risk of EDVs for STEMI (OR 1.05; 95 % CI, 1.00-1.11). Significantly increased risk of STEMI associated with PM2.5 (OR 95 % CI, 1.15 (1.08-1.23) p=0.04))	+	+
Cox, Louis et al.	2017	Two age groups: 18-75; > 75 /PM2.5 ist positively correlated with temperature and CVD Has, except for older males (r= -0.01, p=0.49). Women > 75 had much higher Has than men, as well as CVD HA risk	+	+
Solimini, A. G. et al.	2017	Two age groups: <> 75; mean age men: 72, mean age women: 74 /Air pollution levels were associated with increased AF emergency visits within 24 h of exposure. Effect estimates ranged between 1.4 % (0.7–2.3) for a 10 g/m3 increase of PM10 to 3 % (1.4–4.7) for a 10 g/m3 increase of PM2.5 at lag 0–1 day. Effects were highest for people > 75	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Wichmann, Janine et al.	2013	Two age groups: <> 75, mean ages: 74 (AMI hospitalizations) and 80 (out-of-hospital IHD deaths) /More hospitalizations among the group > 75.	0	+
Buadong, Dongruethai et al.	2009	age groups: < 15; 15-64; > 65 /Exposure on the previous day to PM10 and O3 had a positive association with hospital visits for CVD among ≥65 years-individuals. The increase in CVD hospital visits in this age group was 0.10 % (95 % CI, 0.03–0.19) with a 10 µg/m3 increase in PM10, and 0.50 % (95 % CI, 0.19–0.81) with an increase in O3.	+	+
Khan, R. et al.	2019	Two age groups: 15-64; > 65 /the elderly showed no significant association for any lags examine	-	+
Jalaludin, Bin et al.	2006	age: > 65 /Air pollution were associated with decrease ED attendances for stroke; Increased ED attendances for all CVD, cardiac disease and ischaemic heart disease	+	
Weichenthal, Scott et al.	2017	Mean age: 65 /Each 5 µg/m3 increase in 3-day mean PM2.5 was associated with an increased risk of MI among elderly subjects (≥65 years; OR = 1.06, 95 % CI: 1.03, 1.08); Among the elderly, the strongest association occurred during colder periods (<6.44°C)	+	+
Wettstein, Zachary S. et al.	2018	Age categories: 19+/45-64/> 65 /> 65: greatest increase of Emergency department visits on dense smoke days and > 65 at lag 0 (RR: 1.15 %, 95 % CI: 1.09, 1.22); all-cause cerebrovascular visits were associated with smoke, especially for older people: (1.22 (1.00, 1.49), dense smoke, lag 1). Respiratory conditions were also increased: 1.18 (1.08, 1.28), adults > 65, dense smoke lag 1)	+	+
Yorifuji, Takashi et al.	2014	Mean age: 80 /all pollutants (except ozone) averaged during the period 0-6 years were positively associated with the risk of onset of cardiovascular or cerebrovascular disease; OR after 1 interquartile range increase in SOM: 1.04 (95 % CI, 1.01-1.06) for CVD and 1.04 (95 % CI, 1.00-1.08) for cerebrovascular disease; elevated risk of hemorrhagic as well as ischemic stroke	+	
Wang, Xiaoming et al.	2015	Age > 65: Prevalence of AMI in Calgary: 4.10 (4.40 female, 3.90 male); Edmonton: 4.70 (4.70 female, 4.80 male)	+	+
Peng, Roger D. et al.	2009	Age > 65 years; 119 urban communities (12 million people), no more details; PM2.5 and hospital admissions for cardiovascular disease and respiratory disease; levels of elemental carbon and organic carbon matter were associated with the largest risks of emergency hospitalization	+	
Tian, Yaohua et al.	2017	Age: mean 66.4 years; 43.3 % <65; 63956 subjects; PM and hospital admissions dor ischemic stroke; PM2.5 associated with increased daily admissions for ischemic stroke; association not different between >65 and <65 years old or between males and females	0	+
Chen, Szu-Ying et al.	2014	Two age groups: <> 65 /For people > 65: For ischemic stroke, the mean daily number of ER visits was greater. RR of ER visits	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		for ischemic stroke was increased by Oc, with the estimate of 1.08 (95 % CI; 1.01-1.16) with exposure ti an IQR increase in 3-day average concentrations of OC (3.0 µg/m3)		
Maheswaran, Ravi et al.	2005	Age: 45->85 years, no more details; air pollution and mortality and hospital admissions; 199682 subjects; excess risk of coronary heart disease mortality in areas with high outdoor NOx, a proxy for traffic-related pollution	+	+
Rosenthal, F. S et al.	2008	Age: mean age 60.4 years, subset 60-75 years; 1374 subjects; air pollution and cardiac arrest; results suggest acute effects of short-term PM2.5 exposure in out-of-hospital cardiac arrest	+	+
Colais, Paola et al.	2012	Age: >65 years; 167895 subjects; air pollution and cardiac disease; PM10 has an important effect on hospitalization for cardiac disease was found; sex and older age were susceptibility factors	+	
Wellenius, G. A. et al.	2006	Age: >65 years; 292918 subjects; air pollution and heart failure; increase in PM10 was associated with increase in the rate of admission for congestive heart failure on the same day; effect appeared to be less in patients with secondary diagnoses of hypertension; there was no consistent effect modification by age, gender, race, or any other secondary diagnosis evaluated	+	
Wellenius, G. A. et al.	2005	Mean age: 78.9 +-7.78 /3.07 % increase (95 % CI, 1.59, 4.57; p<0.0001) in the rate of hospitalization associated with an interquartile range increase in PM10 on the day of admission	+	
Larrieu, Sophie et al.	2007	Two age groups: all ages; > 65 /Daily hospitalizations for cardiovascular diseases were associated with PM10 levels (for a 10 µg/m3 increase, ERR= 0.8 %, 95 % CI: (0.2, 1.5)) and with NO2 (1.1 %, (0.6, 1.6). Stronger effects for people > 65. No association was found between strokes and air pollution levels	+	+
Ma, Y. et al.	2017	age groups: 0~45 years, 45~60 years, ≥60 years: Stronger effects of air pollutants were observed for females and the elderly (≥60 years).	+	+
Zheng, Qiwen et al.	2018	> 65 years and patients with comorbid diabetes were more likely to be hospitalized for cardiac arrhythmia following exposure to high levels of PMs	+	+
Zanobetti, Antonella et al.	2005	increased concentrations of ambient PM10 are associated with increased risk of MI among the elderly	+	+
Wichmann, Janine et al.	2014	77 % over 65 years old, mean age for AMI hospitalisations of 74 years; measurement of hospital admissions between 1985 and 2010 compared to PM; more hospitalisation among men and during cold periods, >75; acute myocardial infarction (AMI) hospitalisations per day 0-23; positive association between AMI hospitalisations and PMRest (6.6 %, 95 % CI 2.1 % - 11.4 %), PM10 (4.1 %, 95 % CI 0.2 % - 8.2 %), sulphate ion in the warm period (1.9 %, 95 % CI 0.4 % - 4.3 %); association for PM 2.5 insignificant; strongest	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		association of PM10 and PMRest with hospital admissions during cold period in the time period 1990-2000		
Martins, Lourdes Conceição et al.	2006	Age > 64: Interquartile range increases in PM10 (26.21 µg/m3) and SO2 (10.73 µg/m3) were associated with 3.17 % (95 % CI; 2.09-4.25) increase in congestive heart failure and 0.89 % (95 % CI: 0.18-1.61)	+	
Barnett, Adrian G. et al.	2006	15-65 years and older; general population (8.3-13.7 % are elderly); association of air pollution and cardiovascular hospital admissions in elderly; all pollutants (CO, NO2, PM) except O3 associated with 5 categories of cardiovascular disease admissions; CO increase caused increased total cardiovascular disease, all cardiac disease, cardiac failure, ischemic heart disease and myocardial infarction	+	+
Chan, Chang-Chuan et al.	2006	Emergency admissions for cerebrovascular diseases among adults were positively associated with increasing urban air pollution levels of O3 lagged 0 day and CO lagged 2 days	-	
Koken, Petra J. M. et al.	2003	>65: O3 is associated with an increase in the risk of hospitalization for acute myocardial infarction, coronary atherosclerosis, and pulmonary heart disease; CO is significantly associated with congestive heart failure; No association was found between PM or NO2 and any of the health outcomes. Males tend to have higher numbers of hospital admissions for all of the selected cardiovascular diseases, except for congestive heart failure.	+	

Feinstaub	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	66

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Ye, Xiaofang et al.	2016	Two age groups: 41-65; > 65 /People over 65 years accounted for almost three quarters of the total CHD morbidity: associations appeared to be more evident in the male and the elderly.PM2.5 (all seasons): > 65: 0.80 (95 % CI, 0.47, 1.13, p<0.05); PM10 (all seasons): 0.27 (0.15, 0.40, p<0.05)	+	+
Sade, Maayan Yitshak et al.	2015	Mean Age: 70 /higher risk for ischemic stroke associated with PM among young adults <55	-	+
Rückerl, Regina et al.	2006	Age: mean 66 /Strongest effect for accumulation mode particles with a delay of two days (OR, 3.2; CI, 1.7, 6.0); Results were consistent for UFPs and PM10, which also showed a 2d delayed response (OR, 2.3; CI 1.3, 3.8; and OR 2.2; CI, 1.2, 3.8)	+	+
Kunzli, N. et al.	2005	Age: > 40 /Results suggest significant age and sex interactions in the older age group. Especially for women > 60 (15.75 %, 5.7-26.6 %)	+	++
Xia, R. et al.	2017	Mean age: 64, 57 % > 70 years old /Highest ORs of OHCA for a 10 g/m3 increase of PM2.5 were observed at Lag Day 1 (1.07;	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		95 % CI: 1.04-1.10) especially for people > 70: 1.09; 95 % CI: 1.05-1.13)		
Hartiala, Jaana et al.	2016	Mean age: 64 /Patients with Coronary artery disease: Increase of PM2.5 was associated with increase likelihood of Mild atherosclerosis: (OR 1.43, 95 % CI 1.11-1.83, p=0.005); severe: OR 1.63; 95 % CI 1.26-2.11, py0.0001). Higher risk of incident myocardial infarction (HR 1.33, 95 % CI 1.02-1.73, p=0.03)	+	+
Liao, Duanping et al.	2009	Mean age: 67.5 /prevalence of 12-lead ECG detected VE, SVE and both ectopy: 1.68 %, 2.88 % and 0.12 %. Resulting in any actopy-rate of 4.68 %	+	+
Yue, Wei et al.	2007	Mean age: 66 /An increase in QT interval and a decrease in T wave amplitude were observed in association with traffic-related PM exposure during 0–23 h before the ECG recordings. The inflammatory marker vWF increased in association with PM and combustion-generated aerosols at different exposure lags. All source particles had positive associations with CRP levels above the 90th percentile (8.5 mg/l).	+	+
McCracken, John et al.	2010	Mean age: 74 (56-94) /Increase in annual black carbon (0.25µg/m3) was associated with a 7.6 % decrease (95 % CI, -12.8 - -2.1) in LTL. Stronger association for people > 75	+	++
Kaelsch, Hagen et al.	2014	Mean age: 60 (45-75) /PM2.5 and Light were associated with an increasing TAC-burden of 18.1 % (95 % CI:6.6; 30.9 %) per 2.4 mg/m3PM2.5 and 3.9 % (95 % CI: 0.0; 8 %) per 5dB(A).	+	+
Kashima, Saori et al.	2017	Mean age: 81 (people > 65 were included) /There was a higher risk of cardiovascular (3-day lag), cerebrovascular (same day), and respiratory (3-day lag) disease onset. Patients with respiratory diseases in history had a higher risk of CVD (OR: 1.09 (95 % CI =1.00, 1,19) OR=0.99 for interaction and OR=1.15 for cerebrovascular disease onset. Patients with diabetic background had a higher risk of cerebrovascular disease onset (1.09, 1.00, 1.19).	+	+
Kojima, Sunao et al.	2017	Three age groups: 20-65; 65-75; > 75 /significant association between AMI and Asian dust was observed in patients > 75 (OR 1.71 %; 95 % CI: 1.10-2.68)	+	+
Kaufman, Joel D. et al.	2016	Mean age: 62 (45-84) /stronger association between PM2.5 and coronary artery calcium progression in people > 65. The estimate for the effect of a 5 µg/m3 higher long-term exposure to PM2·5 in intima-media thickness was −0·9 µm per year (95 % CI −3·0 to 1·3).	+	++
McGuinn, Laura A. et al.	2016	Mean age: 60 (20-93) /participants aged 65 years old or greater had higher odds of having a CAD score >23 for each 1 µg/m3 increase in annual average PM2.5 (OR: 1.20, 95 % CI: 1.08, 1.32) compared to those participants under the age of 65 (OR: 1.06, 95 % CI: 0.97, 1.16), with p=0.08 for modification.	+	++
Hennig, Frauke et al.	2014	Age: 45-74; mean age: 59; 64 (baseline; follow-up)) /A 1-µg/m3 increase in total PM2.5 was associated with a 4.53 % increase in hs-CRP concentration (95 % CI: 2.76, 6.33 %). hs-	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		CRP was 17.89 % (95 % CI: 7.66, 29.09 %) and 7.96 % (95 % CI: 3.45, 12.67 %) higher in association with 1-µg/m3 increases in traffic- and industryspecific PM2.5, respectively. Results for PM10 were similar. Long term exposure to local traffic-specific PM was more strongly associated with systemic inflammation than total PM.		
Chen, Szu-Ying et al.	2015	Age: > 65, mean age: 74 /Diastolic BP was associated with 1-years exposures to air pollution with estimates of 0.73 (95 % CI; 0.44, 1.,03) for PM10, 0.46 for PM2.5-10, 0.62 for PM2.5, 0.34 for Nox and 0.65 for NO2	+	
Zhao, Ang et al.	2015	Mean age: 65 /Short-term exposure to PM air pollution was significantly associated with elevated SBP and BP, but not DBP. For PNC, the association strengthened with decreasing diameter in a wide range of 0.25 to 1 µm. For PMC, PM2.5 was significantly associated with BP.	+	+
Panasevich, S. et al.	2009	Age: 45-70, mean age: 59 (men) and 62 (women) /Long-term exposures to traffic NO2 and heating SO2 emissions showed consistent associations with IL-& levels. 30 years traffic exposure: associated with a 64.5 % (95 % CI, 6.7 % to 153.8 %) increase in serum IL-6 per 28.8 % mg/m3	+	+
Mcbride, Sandra J. et al.	2011	Age: 71-97, mean age: 82 /Strong relationship between decreased HRV and total personal exposure to PM2.5 at a lag of 1 day.	+	+
Dominguez-Rodriguez, Alberto et al.	2015	Mean age: 64 (patients), 63 (without events) /no significant differences regarding the gaseous pollutants and meteorological data. BC (OR: 1.007, 95 % CI: 1.002–1.011, P = 0.004) and serum malondialdehyde (OR: 4.25, 95 % CI: 1.99–9, P b 0.001) were significant predictors of MACE at 30 day follow–up	+	++
Yitshak Sade, M. et al.	2015	Mean age: 69 /Effect of CO on AF onset was similar among patients younger and older than 65 (OR=1.06, p=0.340 and OR=1.03, p=0.473)	0	++
Baccarelli, Andrea et al.	2008	Mean age: 72 /Genetic and nutritional variations in the methionine cycle affect HRV, either independently or by modifying the effects of PM2.5. The association between PM2.5 and HRV was modified by different polymorphisms.	+	+
Stieb, David M. et al.	2017	Age groups: 55-59; 60-64; 65-69; 70+ /Interquartile increase in the air quality health index (AQHI) was associated with a significant (p<0.05) increase in heart rate (2.1) and significant decreases in high frequency power (-19.1 %), root mean square of successive differences (-9.5 %) and reactive hyperemia index (-6.5 %)	+	++
Schneider, Alexandra et al.	2010	Age: 52-76. Mean age: 66 /Significant effects of ambient particulate air pollution on DC and HRV parameters (reflecting parasympathetic modulation of the heart in patients with CAD) observed	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Lipsett, Michael J. et al.	2006	Age: > 60; mean age: 71 /Decrements in several measures of HRV were consistently associated with PM10 and PM10–2.5; little relationship of HRV variables with PM2.5 concentrations. 1-4 % decrease in HRV per 10-µg/m3 increase in PM10 and PM10-2.5	+	+
Sørensen, Mette et al.	2014	Age: 50-64, mean age: 56, 58 /A higher mean annual exposure at time of diagnosis of 10 mg/m3 NO2 and 10 dB road traffic noise at residential address was associated with ischemic stroke with IRR of 1.11 (95 % CI:1.03, 1.20) and 1.16 (95 % CI: 1.07, 1.24) (single-exposure-model)	+	++
Dubowsky, Sara D. et al.	2006	Two age groups: 60-79; 80-95 /positive associations between longer moving averages of PM2.5 and WBCs with a 5.5 % (95 % CI, 0.10-11 %) increase per interquartile increase (5.4 µg/m3) of PM2.5. Interquartile increase in the 5-day mean PM2.5 (6.1µg/m3) was associated with a 14 % increase in CRP (95 % CI, -5.4-37 %)	+	+
Hart, Jaime E. et al.	2015	Mean age: 63; 68 /For each 10 lg/m3 increase in 12-month average PM2.5, PM2.5 to 10, and PM10, the HRs were 1.44 (95 % CI: 1.23 to 1.68), 1.17 (95 % CI: 1.05 to 1.30), and 1.19 (95 % CI: 1.10 to 1.28) among women with diabetes. Higher risk was suggested for women > 70.	+	+
Liu, Ling et al.	2009	Median age 78 years (64-96); 28 subjects; increases in black carbon and PM2.5 were associated with increases in blood pressure, heart rate, endothelin-1, vascular endothelial growth factor, and oxidative stress marker thiobarbituris acid reactive substances, and a decrease in branchial artery diameter	+	++
Mills, Nicholas L. et al.	2008	Age: 59 +-2; Exhaled breath 8-isoprostane concentrations increased after exposure to CAPs (16.9 +- 8.5 vs. 4.9 +- 1.2 pg/mL, p<0.05)	0	++++
O'Donnell, Martin J et al.	2011	Age: mean 72.5 years, no more details; 9202 subjects; PM2.5 was positively associated with the risk of ischemic stroke onset among patients with a medical history of diabetes mellitus (excess relative risk per 10-µg/m3 increase in PM2.5= 10.6 % [95 % CI = 0.8 % to 21.5 %])	+	
Adar, Sara D et al.	2013	Age: 45-84 years, mean 62 years; 4944 subjects; PM and the progression of carotid intima-medial thickness (IMT); long-term PM2.5 concentrations are associated with increased IMT progression; little difference by risk factors (</>70 years of age)	0	++
McClure, Leslie A. et al.	2017	Age: mean 70 years; 30239 subjects; PM and the risk of stroke; no association found between PM2.5 exposure and stroke	0	+
Qiu, Hong et al.	2017	Age: >65 years; 66820 subjects; PM exposure and incidence of stroke; hazard ratio significantly increases with PM2.5 exposure for ischemic stroke, but not for hemorrhagic stroke; estimates for ischemic stroke were higher in older participants (>70 years), less educated participants and in men for current smokers	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Whitsel, Eric A. et al.	2009	Age: three groups - mean 64-69 years; 4295 subjects; PM, glucose homeostasis and heart rate variability; PM10 exposure inversely associated with heart rate variability; associations were stronger among participants with diabetes	+	++
Banerjee, M. et al.	2012	Age: 21-65; Median age: 37 (control); 35 (Delhi) /Increase in prevalence of hypertension with increasing age group observed: 63.9 % in 60+ age group	+	++
Haikerwal, Anjali et al.	2015	Two age groups: 35-64; > 65 /Increase in IQR of 9.04 lg/m3 in PM2.5 over two days moving average (lag0-1) was associated with a 6.98 % (95 % CI, 1.03 %-13.29 %) increase in risk of out-of-hospital cardiac arrests, with strong association shown by elderly: 7.25 %, 95 % CI; 0.24 %-14.75 %). Increase in IHD-related hospital admissions at lag 2 days; strong associations shown by older people: 2.41 %, 95 % CI; 0.82 %-5.67 %)	+	+
Goncalves, Fabio L. T et al.	2007	Age: > 65 /positive loadings between CVD PM10 and SO2, except ozone	0	
Panasevich, Sviatlana et al.	2013	Age: 45-75, mean age: 60 /One-years traffic NO2 exposure was associated with higher IL-6 levels in each additional IL6-174C allele, and 1-years heating-SO2 exposure with higher levels od TNF-a in TNF-308AA homozygotes versus -308G carriers.	+	+
Levinsson, Anna et al.	2014	Age: 25-75, mean age: 60 (AMI), 59 (population controls hypertensive), 44 (population controls non-hypertensive) /Air pollution was significantly associated with risk of AMI: OR 1.78 (95 % CI 1.04-3.03) per 10 mg/m3 of long-term NO2 exposure. Three GSTP 1 SNPs were significantly associated with hypertension	+	+++
Pope, C. Arden et al.	2006	Mean age: 60-65 /increase of 10 µg/m3 was associated with increased risk of acute ischemic coronary events equal to 4.5 % (95 % CI, 1.1-8.0)	+	+
Stafoggia, M et al.	2014	Age groups: 25-74 years, mean 48 years; 9995 subjects; air pollution and cerebrovascular events; PM2.5 exposure associated with increased risk of incident stroke, similar results for PM10; association with PM2.5 was apparent among those >60 years of age, among never-smokers, and among participants with PM2.5 exposure <25 microg/m3	+	++
Diez Roux, Ana V. et al.	2008	various age groups: 45-84 years, 43.6 % over 65 years; 5172 subjects; air pollution and atherosclerosis; Intimalmedial thickness weakly positively associated with exposure to PM10 and PM2.5; no consistent associations with vulnerable groups (older)	0	++
Zhang, Zhenyu et al.	2016	Age: mean 60.39 years; 74880 subjects; air pollution and self-reported hypertension; PM was associated with small increases in risk of incident hypertension, particularly among younger women and the obese	-	++
Rosenlund, Mats et al.	2006	Age: 45-70 years, mean 60.9; 5452 subjects; urban air pollution and myocardial infarction; no association between air pollution	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		and overall myocardial infarction, but an increased risk of fatal myocardial infarction		
Fuks, Kateryna et al.	2011	Age: 45-75 years; 4291 subjects; urban air pollution, traffic noise and arterial blood pressure; PM2.5 associated with increased mean systolic and diastolic blood pressure; relationship independent of road traffic noise	+	++
Wittkopp, Sharine et al.	2016	Age: >65 years, mean 84.7 years; 43 subjects; traffic air pollution, cardiovascular disease and gene expression; BFE2L2 gene expression links associations of traffic-related air pollution with phase I and II enzyme genes at the promoter transcription level	+	+
Hoffmann, B. et al.	2007	Age: 45-75, two age groups: <> 60; stronger association in men and younger and less educated participants.	-	++
Dorans, Kirsten S. et al..	2016	Mean age: 52; 59 /No consistent associations with detectable CAC, continuous CAC or CAC progression. Heterogeneous associations of distance to major roadway with odds of detectabe CAC by hypertensive status.	0	+
Host, S et al.	2008	Three age groups: 0-14; 15-64; > 65 /Positive association with hospitalisations for cardiovascular reasons within all age groups. Trend with PM2.5-10 were in general weaker and only significant for ischemic heart disease in the elderly (ERR 6.4 %, 95 % CI 1.6-11.4)	0	++
Chen, Szu-Ying et al.	2012	Two age groups: <> 60 /PM10 exposure was more strongly associated with reduction of pulse pressure among persons > 60. The associations of PM10 with systolic BP and pulse pressure were strongest in the older subjects after a 1-day lag (-2 mm Hg of systolic BP (95 % CI= -3 to -1) and -3 mm Hg of pulse pressure (95 % CI= -4 to -2)	+	++
Stankovic, Aleksandra et al.	2012	Age: > 65; all ages /The daily mean number of all age cardiovascular hospitalisations was 12.46 +-6.26 (0-38) and 5.92+-3.29 (0-20). OR of unipolutant regression model for person >= 65 yrs was 1.00135 (95 % CI: 0.97835 to 1.02489), and the estimated OR of bipolutant model was 1.00975 (95 % CI: 0.99457 to 1.02394) per 10 mu g/m(3).	-	+
Chen, Hong et al.	2014	Age: <60; 60-69; > 70; mean age: 50 /PM2.5 was associated with increased incidence of hypertension: HR for incidence of hypertension for people <60: 1.09; 60-69: 1.19 (95 % CI 1.01-1.40); for people > 70: 1.20 (0.99-1.45)	+	++
Sohn, Jungwoo et al.	2016	Age groups: < 65; 65-79; > 80 /The RRs of ED visits were not significant for PM10, but for people > 80: (1.019; 1.002-1.037). Differences in ED visits for IHD in people > 80 revealed. People > 80 were susceptible to PM-associated ED visits.	+	+
Luttmann-Gibson, Heike et al.	2010	Mean age: 72 /—Increased systemic inflammation is associated with autonomic dysfunction in the elderly. Air pollution effects on reduced SDNN are stronger in subjects with elevated systemic inflammation.	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Chen, Li et al.	2014	Age groups: 25-64; 65-74; 75-84; > 85 /The AQHI, NO2 and CO were positively associated with the number of ED visits for ischemic stroke during April-September, and associations were strongest for persons > 75. In this age range, the ORs (95 %CI) for an IQR increase of AQHI in 1–24 h, 25–48 h, and 1–72 h lag periods were 1.23 (1.08–1.40), 1.15 (1.01–1.31), and 1.30 (1.10–1.54).	+	+
Sen, Taner et al.	2016	Age groups: 30-54; 55-65; > 65, mean age: 61 /people < 55 more susceptible than older ones for AMI	-	++
Dragano, N. et al.	2009	Age: 45-74, mean age: 59 (men); 60 (women) /High traffic exposure was associated with coronary calcification in all social groups. People with low socioeconomic status were more often exposed to heavy traffic	+	+
Delfino, Ralph J. et al.	2010	Age: > 65 /Positive associations of systolic and diastolic BP with air pollutants. Strongest associations were with organic carbon, multiday average exposures, and time periods at home. An IQR increase in 5-day average organic carbon (5.2 µg/m3) was associated with 8.2 mm Hg	+	+
Peters, Annette et al.	2013	Age: 25-74, age groups: 25-49; 50-64; 65-74 /Exposure to traffic was associated with higher risk of AMI for older people. RR (65-74 years) 4.66 (3.29-6.61)	+	++
Bauer, Marcus et al.	2010	Age: 45-75, mean age: 59 /Median CIMT of the participants was 0.66 mm (IQR 0.16mm). An IQR increase in PM2.5 (4.2 µg/m3), PM10 (6.7µg/m3) and distance to high traffic (1939m) was associated with a 4.3 %, 1.7 %, and 1.2 % increase in CIMT	0	+
Chahine, Teresa et al.	2007	Mean age: 72 /PM2.5 was significantly associated with SDNN (p=0.04) and HF (p=0.003) in all subjects.	+	+
Devlin, R. B. et al.	2003	Age: 60-80, mean age: 66 /Air pollution particles caused significant decreases in HRV (59.6 %) in both time and frequency domains immediately following exposure.	+	+++
Gold, Diane R. et al.	2005	Age: 61-88, median age: 73 /Increases in levels of ambient BC in the 12hr before testing were associated with between-week depression in the mean ST-segment levels.	+	+
Holguín, Fernando et al.	2003	Mean age: 79 /Ambient levels of PM2.5 and O3 can reduce the high-frequency component of heart rate variability. Hypertension patients are particularly susceptible to this effect. A 10- µg/m3 increase in PM2.5 was associated with a 5.0 % change in HRV–HF.	+	+
Pope, C. Arden et al.	2004	Age: 57-89 /A 100 µg/m3 increase in PM 2.5 was associated with approximately a 35 (SE=8)-msec decline in standard deviation of all normal RR intervals.	+	+

Feinstaub	**Mortalität**	I00-I99 Krankheiten des Kreislaufsystems	44

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Ensor, Katherine B. et al.	2013	Mean age: 64 /Average increase of 6 µg/m3 in PM 2 days before onset was associated with an increased risk of OHCA (1.046; 95 % CI, 1.012-1.082). 20-ppb ozone increase for the 8 hour average daily maximum was associated with an increased risk of OHCA on the day of the event (1.039; 95 % CI, 1.005-1.073). Each 20-ppb increase in ozone in the previous 1 to 3 hours was associated with an increased risk of OHCA (1.044; 95 % CI, 1.004-1.085). Risks were especially higher for people > 65	+	+
Forastiere, F. et al.	2005	Three age groups: 35-64; 65-74; > 75 /Mean age: 78: The majority of the events occurred in the oldest age group. Association with out-of-hospital coronary deaths was statistically significant for PNC, PM10 and CO. Air pollution on the day of death had the strongest effect (e.g. 7.6 % increase (95 % CI, 2.0-13.6 %))	+	+
Lo, Wei-Cheng et al.	2017	More than 80 % of deaths due to high blood glucose occurred in people > 65. High blood glucose accounted fot the largest number of deaths (14900, 95 % CI: 11.850-17.960). 95.6 % of deaths occurred in those over 45 years old.	+	+
Delfino, Ralph J et al.	2009	Mean age: 84; all > 65 /primary combustion markers (EC-BC, Ocpri, CO, Nox-NO2) were positively associated with inflammatory biomarkers and inversely associated with erythrocyte anti-oxidant enzymes. PN and PM0.25 were more strongly associated with biomarkers than PM0.25-PM2.5	+	
Berglind, Niklas et al.	2009	Three age groups: 35-64, 65-74, > 75 /PM10 and particle number concentrations were associated with increased total nontrauma mortality for people 35-74 (95 % CI, 2.8 %-8.5 %) per 10.000/cm³ and 5.1 % [1.6 %-9.3 %] per g/m3.	+	+
Chen, Renjie et al.	2010	Three age groups: 5-64; 65-74; > 75 /37.4 % of deaths in the group > 75. For age group > 75: Effects of all 4 pollutants on both total and cardiovascular mortality were statistically significant: 10 µg/m3 increase, 95 % CI: PM10 - 0.54 (0.11, 0.97), SO2 - 0.66 (0.15, 1.17), NO2 - 2.80 (0.65, 1.95), CO - 0.03 (0.00, 0.07)	+	+
Luo, Kai et al.	2016	Two age groups: <> 65 / Elderly are more susceptible to PM2.5 mortality (0.46, 95 % CI; 0.31, 0.62 for CVD mortality); 0.45 (0.24, 0.66) for CBD mortality and 0.52 (0.29, 0.,74) for IHD mortality, with higher estimates for males.	+	+
Shih, Regina A et al.	2011	Mean age: 63 (50-79) /508 participants das Venous Thromboembolism VTEs (2.6 events per 1000 person-years). VTE risk was not associated with PM2.5 or PM10	0	
Su, Chang et al.	2015	Two age groups: 0-74; > 75 /Adverse effects of particulate air pollution observed on CVD mortality. More pronounced in elderly: 3.3 % change in CVD mortality per an interquartile range increase	+	+
Liu, Yisi et al.	2015	Two age groups: <> 65 /For people older than 65 years: every 10 µg/m3 increase in NO2 was associated with a 1.6 % (95 % CI: 0.1 %, 3.1 %) increase in CVD mortality	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Zhang, Chao et al.	2017	Age: > 75 /For every increase of 10 µg/m3 in SO2, NO2, and PM10 levels, CVD mortality increased by 5.26 % (95 %CI: 3.31 %–7.23 %), 2.71 % (95 %CI: 1.23 %–4.22 %), and 0.68 % (95 %CI: 0.33 %–1.04 %) at a lag03. After modeling, PM10 and SO2 remained associated with CVD mortality	+	+
Mordukhovich, Irina et al.	2016	Mean age: 76 /positive associations between sub-chronic and long-term PM2.5 exposure and corrected QT duration, with the strongest results for longer-term exposures. 1 standard deviation increase in 1-year PM2.5 was associated with a 6.3 ms increase in corrected QT (95 % confidence interval: 1.8, 11)-->risk factor for cardiac arrhythmia and sudden death	+	+
Cappellari, Manuel et al.	2017	Mean age: 71 (MINAP), 73 (HES), 82 (ONS mortality); NO2 was associated with higher risk of hospital admission: age 70+: non MI-admissions /mortality: greater risk from O3 exposure on all CVD and IHD deaths (for the > 70); older age were associated with higher rate of 3-month mortality	+	
Gan, Wen Qi et al.	2012	mean 59±10 years: association black carbon to death from CHD 4 %(95 %CI: 1, 8) increases in coronary mortality; a 10-dB(A) elevation in residential noise levels was associated with a 9 % increase in CHD mortality	+	
Chung, Mei et al.	2015	Mean age: 58 /There were no significant associations for PM2.5 or BC.	0	
Auchincloss, Amy H. et al.	2008	Age: 48-84, mean age: 62 /PP and SBP were positively correlated with PM2.5. 10 µg/m3 increase in PM2.5 was associated with 1.12 mmHg higher pulse pressure (95 % CI, 0.28-1.97) and 0.99 mmHg higher systolic BP (95 % CI, -0.15-2.13)	+	
Kettunen, Jaana et al.	2007	Age: > 65 /Positive association of fine particles with stroke mortality during warm season: 6.9 %; 95 % CI, 0.8 %-13.8 %; and 7.4 %; 95 % CI, 1.3 %-13.8 %)	+	
Gutierrez-Avila, Ivan et al.	2018	Age: >25, >65 /10 µg/m3 increase in aerosol optical depth PM2.5 was associated with increase cardiovascular (1.22 %; 95 % CI, 0.17-2.28) and cerebrovascular mortality (3.43 %; 95 % CI, 0.10-6.28) for lag days 0-1. Stronger for people > 65	+	+
Pope, C. Arden et al.	2009	Mean age: 57 /Relative risks of cigarette smoking are not as high for elderly as for younger people (95 % CI)	-	+
Gan, Wen Qi et al.	2010	Age: 45-85, two age groups: <> 65, mean age: 59 /risk of CHD was lower for people > 65 than for those <65	-	+
Hart, Jaime E. et al.	2013	Mean age: 63, 64 /Living close to high traffic was associated with higher risk of an incident MI (HR=1.11; 95 % CI=1.01-1.22) and higher risk of all-cause-mortality (1.05; 1.00-1.10)	+	+
Puett, Robin C. et al.	2009	Mean age: 62 /Increased risk of all-cause mortality (HR=1.26; 95 % CI, 1.02-1.54) and fatal CHD (HR=2.02; 95 % CI, 1.07-3.78) associated with each 10-µg/m3 in PM2.5 in one year	+	+
Delfino, Ralph J. et al.	2008	Age: > 65; mean age: 85 /significant associations for CRP, IL-6, sTNF-RII, and sP-selectin with outdoor and/or indoor	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		concentrations of quasi-ultrafine PM <0.25 µm in diameter, EC, Ocpri, BC, PN, CO and NO2 from the current-day and multiday averages		
Ueda, Kayo et al.	2009	Age 0->75, 80-87 % over 65 years old (9 groups); 67897 subjects; PM2.5 exposure and mortality for heart diseases; positive association was observed between heart disease mortality and PM2.5 at lag 0; effect of PM2.5 on acute myocardial infarction and cardiac arrhythmia and conduction disorders was stronger at lag 0 for the younger population (0-64); associations were not clear in mortality of the elderly	-	+
Qian, Yifeng et al.	2013	Age 65–75, ≥75; 66366 subjects; air pollution and stroke mortality; total-stroke and ischemic-stroke mortalities significantly associated with PM10, SO2 and NO2; hemorrhagic stroke significantly associated with SO2 and NO2	+	
Wong, Martin C. S. et al.	2014	Age: mean 77.8 years; 223287 subjects; association between air pollution and mortality; short-term exposure to NO2, PM10 and O3 were associated with all-cause mortality; all-cause mortality was increased with lower temperature in cold season; results significant among those aged >65 years	+	+
Maheswaran, Ravi et al.	2010	Two age groups: <> 70, mean age: 70 /HR for after stroke mortality associated with an 10-g/m3 increase in Exposure to Outdoor NO2 and PM10 concentrations: 70+ NO2: 1.18 (0.99-1.40, 95 % CI); 70+, PM10: 1.20 (0.77-1.87, 95 % CI)	+	+
Yamazaki, S. et al.	2007	Age > 65, all ages /Risk of death due to intracerebral haemorrhage from April to September (OR=2.4, 95 % CI, 1.48-3.899, for exposure to PM7 of more than 200 µg/m3	+	+
Dastoorpoor, Maryam et al.	2018	Three age groups: < 18; 18-60; > 60 /<significant relation between an IQR increase in PM10 and cardiovascular deaths for all people, > 60 years old and under 18 years old after 3-13 days' lags. > 60 years old: IQR-increase: 273.3 µg/m3, the RR for cardiovascular deaths increased 1.012 (95 % CI: 1.001-1.023) and 1.013 (95 % CI: 1.001-1.025)	0	+
Tonne, Cathryn et al.	2013	Age: >25 years, mean 68 years; 154204 subjects; air pollution and acute coronary syndrome (ACS); mortality from all causes was higher among individuals with greater exposure to PM2.5 in survivors of hospital admission for ACS	+	+
Bjor, Bodil et al.	2010	Age: two groups - <60 years and >60 years; 13621 subjects; exposure to dust among iron-ore miners and mortality from myocardial infarction (MI); MI mortality significantly increased by dust; none of the exposures significantly increased the risk in the group >60 years	0	+
Halonen, J. I et al.	2009	Age: >65 years; air pollution and cardiorespiratory mortality; all particles had especially adverse respiratory health effects among elderly; associations were stronger for respiratory than for cardiovascular outcomes	+	
Bartell, Scott M. et al.	2013	Mean age: 83.3 /Ventricular tachycardia was significantly increased in association with increases in marker of traffic-	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		related particles (RR (95 % CI, 1.50 (1.02, 2.20), p=0.039) secondary organic carbon and ozon		
Puett, Robin C. et al.	2011	Mean age: 57 /fully adjusted HR for CVD: 1.01 (95 % CI, 0.93-1.10), No association of chronic PM exposures with all-cause mortality and cardiovascular outcomes in models with time-varying covariates	0	+
Kowalska, Malgorzata et al.	2012	Two age groups: <> 65 /Mortality due to cardiovascular diseases and illnesses is highest in the elderly female population. The RR of total and cardiovascular mortality were 1.004 (95 % CI: -1.003-1.010) and 1.002 (95 % CI: -1.011-1.015)	+	++
Wilker, Elissa H. et al.	2013	Two age groups: <> 75, mean age: 72-79 /Deaths for people > 75: 889; 687 events. HR=1.18 (1.00-1.40); no effect of age or socioeconomic factor	0	++
Rodrigues, Poliany Cristiny de Oliveira et al.	2018	Age categories: 45-64; 65-85 /Highest death rate in people 65-85 years old (65.65 %), males (54.07 %). 862 deaths for the people 65-85 in the high exposure to vehicular traffic-group and 809 deaths in the low traffic group were observed	+	+
Milojevic, Ai et al.	2014	Mean age: 71 (MINAP), 73 (HES), 82 (ONS mortality); NO2 was associated with higher risk of hospital admission: age 70+: non MI-admissions /mortality: greater risk from O3 exposure on all CVD and IHD deaths (for the > 70)	+	
Stankovi_, Aleksandra et al.	2007	Age: > 65 /Daily number of deaths among persons > 65 was 2.19 +- 1.51 (0-3). Cardiovascular mortality is not related to ambient air pollutants concentrations. There is an increased risk of cardiovascular death with increase of 10 µg/m3 in SO2 and BS, but this is not signicant.	0	
Luttmann-Gibson, Heike et al.	2006	Age: 54-90, mean age: 70 /An IQR of 5.1 µg/m3 in SO42- (previous day) was associated with a decrease of -3.3 % SDNN (95 % CI; -6.0 %nto - 0.5 %), -5.6 % r-MSSD (-10.7 % to -0.2 %) and -10.3 % HF (-19.5 % to -0.1 %). The results were similar for PM2.5	+	
Jerrett, Michael et al.	2013	Mean age: 56; 57 /PM, O3 and NO2 were positively associated with ischemic heart disease mortality. NO2 and PM were associated with all-cause mortality. Only NO2 had significantly positive associations with lung cancer mortality	+	+
Revich, Boris et al.	2010	Two age groups: all ages; > 75 /Compared to all ages-mortality, the effects were typically 1.2-1.5 fold higher in the elderly. PM10 mortality relationships were significantly modified by O3 levels. On the days with O3 concentrations above the 90 %, PM10 risk for all-cause mortality was 3 fold higher and risk for cerebrovascular mortality was 4 fold higher-	+	+
Raaschou-Nielsen, Ole et al.	2012	Age: 50-64, mean age: 56; 59 /levels of NO2 at residence were significantly associated with mortality from cardiovascular disease (MRR, 1.26; 95 % CI, 1.06-1.51, per doubling of NO2 concentration) and all causes (MRR, 1.13; 95 % CI, 1.04-1.23, per doubling of NO2 concentration)	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Zanobetti, Antonella et al.	2009	Age: 43-75, mean age: 56 /Increases in pollution increased the odds of TWA-MAX > 75th percentile (OR: 1.4; 95 % CI: 1.2-1.6 for 1 µg/m3 increase in 6h mean BC)	+	+

Ozon	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Henrotin, J. B. et al.	2007	Median age: 73 years (lowest value of all groups considered); general population; air pollution and acute stroke; positive association ozone 10 mg/m3 increase and ischemic stroke with 1-day lag OR 1.133 (95 % CI 1.052-1.220) and 0-day lag OR 1.058 (95 % CI 0.987-1.134) only in men over 40 years old,	+	+
Xu, Xiaohui et al.	2013	Age: > 65 years; association of ozone and hospitalization for stroke; 26210 cases; all 0-day lag significant OR = 1.019 (1.000-1.038), males 0-day lag OR = 1.028 (1.000-1.057) and 1-day lag OR = 1.036 (1.007-1.065), females not significant; 1-day lag ischemic stroke hospitalization males OR = 1.043 (1.011-1.076), females not significant	+	-

Ozon	**Mortalität**	I00-I99 Krankheiten des Kreislaufsystems	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Halonen, Jaana I. et al.	2010	Age: > 65 years; general population; ozone and cardiorespiratory mortality; 25 microg/m3 increase in ozone 9.6 % (2.0-17.8) increase of asthma-chronic obstructive pulmonary disease (COPD), 6.4 % (0.63-12.5) 1-day lag for arrhythmia; COPD PM2.5 adjusted at lag day 3 increase of 10.6 % (1.86-20.1) for interquartile increase in O3	+	+
Parodi, S. et al.	2005	ozone and daily mortality; general population, no more details; age: > 75: Increase in mean variation of overall and cardiovascular mortality, at 2-day lag	+	+

Schwermetalle	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	5

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Tellez-Plaza, Maria et al.	2010	Age: > 40 years, mean age 68; 6456 subjects; cadmium and peripheral arterial disease (PAD); For men positive and statistically significant association of cadmium levels with the prevalence of PAD: odds ratio for PAD (highest to lowest quintile) blood cadmium 1.82 (95 % CI 0.82, 4.05) urine cadmium 4.90 (95 % CI 1.55, 15.54), no difference by smoking	+	++
Navas-Acien, Ana et al.	2004	Age: > 60 years (53 %), 2125 subjects; Pb, Cd, smoking and arterial disease; lead and cadmium at levels below safety standards associated with increased prevalence of arterial disease	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Lind, P. Monica et al.	2012	Age: 70 years; 993 subjects; copper and nickel and left ventricular hypertrophy; copper levels related to left ventricular mass index; copper and nickel related to relative wall thickness; no relationship with zinc, aluminium, manganese, molybdenum, mercury, lead, cadmium, cobalt or chromium	+	+
Myong, Jun-Pyo et al.	2014	Age: > 60 years (9 %), 4688 subjects; blood cadmium levels and coronary heart disease risk; cadmium exposure may be associated with coronary heart disease risk in men; cadmium levels among men aged 20 to 35, 40 to 45, 50 to 55, and 60 to 65 years were significantly associated with systolic blood pressure ($p<0.05$)	+	++
Sponder, Michael et al.	2014	Mean age: 63 years; 164 subjects; Cd, Pb and Hg with coronary artery disease (CAD); no prove that urine levels of Cd and blood levels of Hg or Pb play a major role in the genesis of CAD	-	++

Schwermetalle	**Mortalität**	I00-I99 Krankheiten des Kreislaufsystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Tellez-Plaza, Maria et al.	2013	Age: 45-74 years, mean age 56; 3348 subjects; cadmium exposure and cardiovascular disease; urine cadmium concentration causes increased hazard ratios for cardiovascular mortality, cardiovascular disease, coronary heart disease, stroke, and heart failure	+	++

Stickstoffdioxid	**Gesundheitsinfrastruktur**	I00-I99 Krankheiten des Kreislaufsystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Villeneuve, P. J. et al.	2006	Age: > 65 years: no association between outdoor measures of air pollution and all stroke visits in either the winter or summer (p>0.05); Between April and September: risk of an ED visit for ischemic stroke for NO2 (OR = 1.26, 95 % CI = 1.09, 1.46) CO (OR 1.32)	0	++

Stickstoffdioxid	**Morbidität**	I00-I99 Krankheiten des Kreislaufsystems	8

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Andersen, Zorana J. et al.	2012	Median age 56 years: Patients with stroke had higher air pollution levels than the whole cohort and were more likely to be men; obese; current or previous smokers; exposed to environmental tobacco smoke; have hypertension, hypercholesterolemia, or diabetes; drink more alcohol; consume more fat and less fruit; and have <10 years of education; significant association between NO2 and stroke incidence (HR 1.12; 95 % confidence interval, 1.06– 1.18 per interquartile range), but not for age	0	+
Bodin, Theo et al.	2016	Mean age: 69 years: no evidence for an increased risk of MI due to exposure to air pollution at moderate average exposure levels	0	++
Huang, Fangfang et al.	2017	Two age groups: <> 65 years; NO2 and SO2: positive associations were higher in warm seasons and with patients >65 years (p < 0.05)	+	+
Rivera, Marcela et al.	2013	Two age groups: <> 60 years; Stronger associations in men ≥ 60 years of age compared to < 60 men, showing significant associations of NO2 and traffic load in 100 m with IMT (percent difference in IMTcca for NO2, traffic load, and traffic intensity were 4.3 % (95 % CI: 0.2, 8.4), 5.9 % (95 % CI: 1.6, 10.3), and 3.4 % (95 % CI: –0.07, 7.0), respectively, among men ≥ 60 years, and –1.5 % (95 % CI: –5.7, 2.7), –1.5 % (95 % CI: –5.7, 2.6), and 1.2 % (95 % CI: –2.7, 5.0), respectively, among men < 60 years of age	+	++
Routledge, H. C. et al.	2006	Mean age 68 years: all measures of HRV were higher in the patients with coronary artery disease; Blood pressure was unchanged. In patients with coronary artery disease, the changes in HR, blood pressure, and all HRV measures after	0	++++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		pollutant exposure did not differ significantly from those after exposure to air; In healthy volunteers, short term exposure to pure carbon particles does not cause adverse effects on HRV or a systemic inflammatory response.		
Schwartz, Joel et al.	2012	Mean age 72 (men) years: significant positive associations between 1-year average BC exposure and both systolic and diastolic blood pressure. An IQR increase in 1-year average BC exposure (0.32 µg/m3) was associated with a 2.64 mm Hg increase in systolic blood pressure (95 % CI 1.47 to 3.80) and a 2.41 mm Hg increase in diastolic blood pressure (95 % CI 1.77 to 3.05)	+	+
Vencloviene, Jone et al.	2011	Age: > 65 (58.5 %) years: geomagnetic activity variations may increase the traffic-related air pollution effect on acute coronary syndrome (ACS), NO2 pollution interquartile range increase (IQR) on the day of admission and previous day (lag 0–1) in patients < 65 years of age increase the risk of ACS equal to 24 % (95 % CI 0.96–1.60); effect modification of NO2 and geomagnetic activity was observed adjusted OR was 1.61; 95 % CI 1.03–2.53. In elderly patients (> 65 years) no effect: OR 0.99; 95 % CI 0.68–1.45 non-significant).	-	+
Vidale, Simone et al.	2010	Mean age: 68 years; NO2 and PM10 significantly associated with admission and mortality (P value <0.05) and with estimated RR of 1.039 (95 % CI 1.066–1.013) and 1.078 (95 % CI 1.104–1.052) for hospital admission at 2- and 4-day lags, resp.; higher ischemic event rate was found in cool days; No significant estimated relative risk for ozone.	+	-

Bioaerosole	**Morbidität**	J00-J99 Krankheiten des Atmungssystems	4

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Guilbert, Ariane et al.	2018	Age >60 years (24 %): significant increase in asthma hospitalizations was observed for an interquartile range increase in grass (5.9 %, 95 % CI: 0.0, 12.0), birch (3.2 %, 95 % CI: 1.1, 5.3) and hornbeam (0.7 %, 95 % CI: 0.2, 1.3) pollen concentrations. For several taxa including grasses, an age modification effect was notable, the hospitalization risk tending to be higher in individuals younger than 60 years; risk appeared to be stronger for grass and birch pollen concentrations in case of high PM10 and O3 concentrations	-	++
Shiue, Ivy	2015	Age groups: 60-79 years (24 %); > 80 years (4,7 %): No statistically significant associations shown between indoor mildew odour or musty smell and urinary concentrations of environmental chemicals	0	++
Zhang, Fengying et al.	2012	Two age groups: <> 60 years; Strong association between the concentration of pollen in ambient air and the number of consultations for allergic rhinitis. Females had significantly more outpatient visits than males; Young people (20–60 years old) significantly more outpatient visits than older people (over 60	-	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		years old) RR: 2.078** (2.021–2.135), 2.789** (2.727–2.851) 95 % CI p<0,01 rsp.		
Chen, Huang-Chi et al.	2018	Mean age 63 years; 644 subjects; cooking fumes OR 4.73 (95 % CI = 1.65-13.53) for chronic bronchitis for women cooking > 21 times a week	+	+++

Feinstaub	**Gesundheitsinfrastruktur**	J00-J99 Krankheiten des Atmungssystems	21

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Wang, Wenqiao et al.	2015	Mean age: 73 /At residence, concentrations of SO2, PM10, NO2, CO, O3 and AECOPD hospitalization cases showed statistically significant spatially clustered. Workspace: Only the PM10 concentrations showed statistical significance, with a 10 mg/m3 increase of PM10 at workplace associated with a 7 % (95 % CI: (3.3 %, 10 % increase of hospitalizations due to AECOPD	+	
Dirks, Kim Natasha et al.	2017	Age groups: 0-14; 15-64; > 65 years old; 65+: No, NO2, CO: Maximum increase in respiratory hospital admissions for lags between 4 and 7 days	0	+
Guo, Li Juan et al.	2014	Two age groups: 5-65; > 65 /PM10, SO2 and NO2 had significant effects in residents > 65. PM10: 1.14 (0.94, 1.34); SO2: 7.82 (7.15, 8.49); NO2: 5.54 (4.92, 6.16)	+	+
Tao, Yan et al.	2012	Two age groups: <> 65 /Effect of sand-dust weather on health much greater in the elderly > 65: RR: 1.266 (<76: RR: 1.119)	+	+
Chang, Jer-Hwa et al.	2017	Age: <> 75 /PM2.5 appeared to show no significant effect on asthma patients of older than 75 years of age during spring	-	+
Bell, Michelle L et al.	2014	Age: > 65 /PM2.5 was positively associated with cardiovascular hospitalizations. An interquartile range increase in same-day PM2.5 road dust (1.71 µg/m3 was associated with a 2.11 % (95 % CI: 1.09, 3.15 %) and 3.47 % (95 % CI: 2.03, 4.94 %) increase in cardiovascular and respiratory admissions	+	
Mott, J. A. et al.	2005	Age groups: 0-18, 19-39, 40-64, 65+ /People > 65 with previous hospital admissions for any cause (x^2df= 5:98; p =0:015), any cardiorespiratory disease (x^2ldf=5.3, p=0.02), any respiratory disease (x^2ldf=7.8, p=0.005], or COPD (x^2ldf=3.9, p=0.047), were significantly more likely to be rehospitalized.	+	+
Michikawa, Takehiro et al.	2015	Three age groups: < 20; 20-64; > 65 /Elevated concentrations of coarse particulate matter were associated with an increase in respiratory disease-related emergency ambulance dispatches for adults > 65: 9716 dispatches, OR for lag0-1=1.065, 95 % CI=1.023-1.109)	+	+
Ko, F. W. S. et al.	2007	Age 0->65, 35 % over 65 years old; 69716 subjects; air pollution and hospitalization rates; association found between hospital admissions for asthma and levels of NO2, O3, PM10 und PM2.5; younger (0-14 years) tended to have a higher relative risk than	-	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		those aged 15-65 years; elderly (>65) had a shorter lag time to develop asthma exacerbation following exposure to pollutants		
Xu, Qin et al.	2016	Age: 0->60 years, 26 % over 60 years; 92464 subjects; PM and hospital visits for respiratory disease; PM2.5 significantly associated with respiratory emergency room visits; susceptibility to PM2.5 varied by gender and age (females and people 60+ at higher risk)	+	+
Chen, Yue et al.	2004	Age: > 65 /3-day average levels of exposure, RR: 1.13 % (95 % CI: 1.05-1.21) for PM10, 1.08 (1.02-1.15) for PM2.5, 1.09 (1.03-1.16) for PM10-2.5 and 1,05 (1.01-1.09) for COH	+	
Neupane, Binod et al.	2010	Age: >65 years; 345 subjects; long-term exposure to NO2, SO2 and PM2.5 and hospitalization for pneumonia; NO2 and PM2.5 significantly associated with hospitalization for pneumonia; SO2 not associated	+	
Salimi, farhad; Morgan, Geoffrey et al.	2018	Age: >45 years, 35.7 % over 65 years old; 100084 subjects; air pollution and respiratory diseases; NO2 and PM2.5 exposure was positively, but not significantly, associated with asthma; no association found with hospitalization for all respiratory diseases and pneumonia; negative associations found with COPD	0	+
Son, Ji-Young et al.	2013	Age groups:0-14- >75: associations between hospital admissions and short-term exposure to air pollution. stronger associations in younger and older age groups. associations were similar for men and women.	+	+
Liu, Ching-Ju et al.	2016	Age groups:3-18,18-65:adults (18–65 years) and children (3–18 years) are the most vulnerable groups to the effect of PM2.5 compared with infants and elderly people.	-	+
Medina-Ramón, Mercedes et al.	2006	Age: >65 years; overall increase in respiratory hospital admissions associated with PM10 concentrations throughout the year, with a more marked effect during the warm season.	+	
Smargiassi, A et al.	2006	Age: >60 years: Increased odds of being hospitalised for a respiratory compared with a control diagnosis were associated with higher levels of estimated road traffic nearby patients' homes	+	+
Tramuto, Fabio et al.	2011	Age groups:16- >85: association between SO2 and respiratory events among elderly individuals, especially in warm season	+	+
Halonen, J. I. et al.	2008	Age groups:15- >65: air pollution had a lagged association with asthma hospital emergency room visits among children and a more immediate effect on asthma and COPD visits among the elderly. Associations in general were weaker among adults.	+	+
Liu, Jia Coco et al.	2017	Age: > 65. Highest admission rates for respiratory illness among people in the oldest age group. Risks of respiratory admissions on smoke-wave days compared with non-smoke-wave-days increase 10.4 % (95 % CI: 1.9, 19.6) for women and 21.7 % (95 % CI: 0.4, 47.3) for blacks	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Sousa, S. I. V. et al.	2012	Age groups:0-5; >65 excess risk of hospitalisation for respiratory disease higher than 2 % per 10 μgm−3 increase in PM10 concentrations for children <5 years old, of 2 % per 10 μgm−3 increase in SO2 for elderly >65 years old.	0	+

Feinstaub	**Morbidität**	J00-J99 Krankheiten des Atmungssystems	38

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Craig, T. J. et al.	2008	Patients between 60 and 70 had a higher mean and median number of positive skin test responses than younger subjects	+	++
Adar, Sara Dubowsky et al.	2007	Age: > 60 /Increase of 4 µg/m3 in daily PM2.5 concentration was associated with a 13 % (95 % CI, 2-24 %) increase in FENO. Associations with exposures during the trip were strong and statistically significant with a 24 % (95 % CI, 15-34 %) increase in FENO predicted per interquartile increase of 9 µg/m3 in PM2.5	+	+
Sanchez-Soberon, Francisco et al.	2015	Age groups: 10; 45; 75 //Highest pulmonary doses for the three PM sizes were reported for retired people; Average depositions of PM for people > 75: PM1 head: 0.197; TB: 0.053; P: 0,095 /PM2.5-1: 0.530 for head, 0.081 for TB and 0.167 for P. Last group: PM10-2.5: 0,918 for head, 0,034 for TB and 0,004 for P	+	++
Wang, K.-Y. et al.	2013	Age groups: 0-15; 16-65; > 66 /NO, NO2 are positively associated with respiratory diseases, followed by PM10, PM2:5, O3, CO, and SO2. Young outpatients are most sensitive to changing air pollution, followed by the eldest (age >66 years) and age 16–65 years of outpatients. Females are more sensitive in this age group than males.	+	++
Miguel-Díez, Javier de et al.	2016	Mean age: 70 /More frequent admissions were observed during autumn and winter (colder seasons) and higher concentrations of ambient air pollution (NO2, O3)	+	
Liu, Sha; Zhou, Yumin et al.	2017	Age groups: < 40; 41-60; > 60 /Older age was associated with higher COPD prevalence: > 60: prevalence 22.80 %	+	++
Schikowski, Tamara et al.	2014	mean age: 64/70 /only NO2, NOx, PM10 and the traffic indicators were positively, although not significantly, associated with COPD. The only statistically significant associations were seen in females (COPD prevalence using GOLD: OR 1.57, 95 % CI 1.11–2.23; and incidence: OR 1.79, 95 % CI 1.21–2.68).	0	+
Lee, Kang-Yun et al.	2016	Age: 40-80, mean age: 63 (COPD), 70 (controls) /Changes in PM10 for the 1-year averages in quintiles were related to diffusion capacity of the lung for carbon monoxode levels (r=-0.914, p=0.029).	0	+
Bentayeb, Malek et al.	2010	Age: > 65 /PM was significantly associated with usual cough (OR=1.33 (95 % CI: 1.00-1.77) for exposed compared to non-exposed. And SO2 with usual cough (1.55 (1.16-2.08) and phlegm (1.45 (1.04-2.01)). 10 % and 23 % increase in usual cough for a 10 mg/m3 increment in PM10 and a 1 mg/m3	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		increment in SO2 respectively, and a 23 % increase in usual phlegm for a 1 mg/m3 increase in SO2.		
Nkosi, Vusumuzi et al.	2015	Age groups: 55-59; 60-64; 65-69; 70-84; > 85 /70-84 year olds were at an increased likelihood of having COPD (36 %). Increase in age was not significantly associated with having COPD-symptoms or diseases	+	++
Cortez-Lugo, Marlene et al.	2015	Mean age 69 years (43-80 years); 29 subjects; PM2.5 exposure and COPD; exposure associated with reductions in peak expiratory flow (PEF) and increased respiratory symptoms in adults with COPD; reduction observed at morning and at night	+	+
Jo, Eun-Jung et al.	2017	Three age groups (0-15, 16-64, >65), children and the elderly were more susceptible to the effects of PM concentration and weather.	+	+
Hsu, Sha O-I et al.	2011	Age 60-86, 75.5 years mean age; 24 subjects; PM exposure and COPD and/or asthma; nickel showed consistent associations, only with heart rate in COPD patients	0	+
Namdeo, Anil et al.	2011	Age: 0->80 years, 76 % over 60 years; 20961 subjects; short-term air pollution and health outcomes; PM10 and O3 are positively associated with respiratory hospital admissions in the elderly, specifically in the age group 70-79; CO effects seem to be concentrated on the most elderly age group (80+), whereas NO2 seems to have the opposite age-related effect, with lower effects on the more elderly	+	+
Sichletidis, Lazaros et al.	2014	Age: mean 67 years; 872 subjects; air pollution and respiratory health; air pollution was associated with severe nasal obstruction but not with COPD development	+	+
Annesi-Maesano, I et al.	2013	Age: >70 years, mean 82 years; 600 subjects; air quality and health effects; exposure to air pollution cause more hospital admissions in elderly for asthma and chronic obstructive pulmonary disease	+	+
Feng, Cindy et al.	2016	Age groups: <5; 5-14; 15-24; 25-59; 60+ /PM2.5 was strongly associated with ILI risk across all age groups (p<0.01). PM2.5 had the greatest effect sizes for adults (25-59), followed by young adults (15-24) and then elderly (60+) and children.	-	+
Bentayeb, Malek et al.	2015	Two age groups: <> 80, mean age: 82 /People > 80 had a higher risk of reporting breathlessness in exposure to NO2 (aOR 1.58 (95 % CI 1.15-2.20), and wheeze and cough in cases of high levels of CO2 (wheeze: aOR (95 % CI) 1.93 (0.98-3.85); cough: aOR: 2.01 (1.55-2.63), 95 % CI).	+	++
Kaji, Deepak A et al.	2014	Two age groups: <> 80, mean age: 82 /People > 80 had a higher risk of reporting breathlessness in exposure to NO2 (OR 1.58 (95 % CI 1.15-2.20), and wheeze and cough in cases of high levels of CO2 (wheeze: aOR (95 % CI) 1.93 (0.98-3.85); cough: aOR: 2.01 (1.55-2.63), 95 % CI).	+	+
Hansel, Nadia N J et al.	2013	Age: > 40; mean age: 69 //former smokers; Among atopic individuals, each 10 µg/m3 increase in PM was associated with higher risk of nocturnal symptoms (OR, 1.95; p=0.002=, frequent	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		wheezing (OR, 2.49; p=0.02=, increased rescue medication use (b=0.14; p=0.02), dyspnea (b=0.23; p<0.001). Higher breathlessness, cough, and sputum score (BCSS) (b=0.44; P=0.01). No association between PM and non-atopic individuals		
Villeneuve, P. J et al.	2006	Age: > 65 /Mostly no significant associations between daily levels of air pollution and the number of physician visits for rhinitis. In contrast, an IQR in the 10-day average of ragweed particles increased the mean number of daily rhinitis consultations by 6.4 % (95 % CI=0.7-12.4 %)	0	+
Atkinson, R. W et al.	2015	Age: 40-89 years, 42 % over 60 years; 812063 subjects; air pollution and chronic obstructive pulmonary disease (COPD); evidence limited and inconclusive for association between air pollution and COPD	0	++
DeVries, Rebecca et al.	2016	Age: mean 70.1 years; 168 subjects; air pollution and COPD; COPD patients suffer increased risk of COPD exacerbation after short-term exposures to increased concentrations of SO2 and NO2	+	+
Peacock, Janet L et al.	2011	Age: 40-83 years, median age 68.2 years; 125 subjects; air pollution and respiratory health in COPD patients; symptoms but not lung function showed associations with raised pollution levels; dyspnea significantly associated with PM10	+	++
Smith, Genee S et al.	2014	Age: 0->65 years, 28.3 % over 65 years; 5319 subjects; air pollution and pulmonary tuberculosis disease; no indication of a clear dose-response relation	0	+
Epstein, Tolly G et al.	2012	Age: > 65, mean age: 74 /Mean daily residential exposure to ECAT greater than 0.39 µg/m3 was significantly associated with poorer asthma control based on ACQ scores (adjusted β=2.85; 95 % CI, 0.58-5.12; p=0.02). High ECAT levels were also significantly associated with increased risk of asthma exacerbations (adjusted OR, 3.24; 95 % CI, 1.01-10.37; p=0.05)	+	+
Sichletidis, L. et al.	2005	Age groups: 21-40; 41-60: 61-80; 21-80, mean age: 51-55 /Prevalence of COPD (all ages): 5.6 %; 24.7 % for rhinitis, slightly higher for the older people (12.5 % 61-80 years for Thessaloniki, 10.2 % for Erodea, 10.0 % for Greneva, 10.9 % Total)	+	++
Santurtún, Ana et al.	2017	50 % corresponded to those aged over 74 years. Direct association between PM and the number of visits to the emergency room due to COPD. For every 10 µg/m3 increase, the emergency visits rose by 3.34 % (p=0.00005). Stronger effects for people > 74	+	++
Sinharay, Rudy et al.	2018	Age: > 60, mean age: 61, 66, 67 /Walking in Hyde Park led to an increase in lung function in all participants. Patients with COPD reported more cough, sputum and shortness of breath	+	++
McCormack, Meredith C. et al.	2016	Mean age: 69 /significant positive interactions were detected between PM2.5 and temperature (interaction term P, 0.001)Increases in maximal indoor temperature were associated with worsening of daily breathlessness, cough, and Sputum Scale scores and increases in rescue inhaler use 10°F increase in	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		indoor temperature was associated with a 0.38 increase in BCSS score (95 % CI, 0.01-0.67; p=0.01).		
Luttmann-Gibson, Heike et al.	2014	Mean age: 71 /IQR increase of 13.4 µg/m3 in PM2.5 on the previous day was associated with a decrease of -0.18 % (95 % CI: -0.31 to -0.06) and a 5.1µg/m3 IQR increase in SO42- on the previous day was associated with a decrease of -0.16 % (95 % CI: -0.27 to -0.04) in oxygen saturation during the initial 5-min rest period.	+	+
Boezen, H. M. et al..	2005	Age: 50-70 years; 327 subjects; air pollution and susceptibility; elderly with both airway hyperresponsiveness and high total immunoglobulin E are especially susceptible to air pollution	+	+
Ding, Yipeng et al.	2015	Age: two groups - <65 and >65 years; 277 subjects; risk factors for COPD; COPD has a strong correlation with age (older people >65), BMI, biomass smoke, >20 cigarettes/day, and recurrent respiratory infections	+	++
Nakao, Motoyuki et al.	2018	Age: 40-79 years, mean 66.6 years; 75 subjects; air pollution and respiratory symptoms; results suggest that PM, NO2 and O3 cause respiratory symptoms leading to health-related quality of life deterioration	+	+
Zhang, Fengying et al.	2013	Age: two groups - 20-60 and >60 years; 31829 subjects; air pollution and allergic rhinitis; no difference in susceptibility to PM10, SO2 and NO2 between both groups	0	+
Matthews, Nick C et al.	2016	Age: 21-62 years; urban particulate matter also a source of antigen that stimulates the generation of Th2, Th1, and Th17 effector phenotypes, which have been implicated in both exacerbations of asthma and chronic inflammatory diseases; no age related results	0	+
Adamkiewicz, G et al.	2004	Age: median 70.7 years; 29 subjects; air pollution and nitric oxide; ambient air pollution may lead to airway inflammation as measured by exhaled nitric oxide	+	+
Mishra, Vinod	2003	Age: >60 years; 38595 subjects; cooking smoke and asthma; elderly men and women living in households using biomass fuels have a significantly higher prevalence of asthma	+	+

Feinstaub	**Mortalität**	J00-J99 Krankheiten des Atmungssystems	19

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Sahani, Mazrura et al.	2014	Age groups: <14; 15-59; > 60 /Incremental risk of respiratory mortality for elderly males above 60 years at lagged 0 (OR=1.34; 95 % CI = 1.09-1.64 and OR=1.41; 95 % CI=1.09-1.84 respectively); residents aged 60 years showed a higher number of mortality than any other age group.	+	+
Faustini, Annunziata et al.	2013	Relevant age groups: 65-74; 75-84; > 85. Age was clearly an effect modifier out of hospital mortality. Dying at home: IR	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		(95 %) rose to 5.07 % (1.01-9.30 %) for 75-84; and 4.82 % (1.81-7.92 %) for those > 85 years		
Dimakopoulou, Konstantina et al.	2014	Three age groups: < 60; 60-75; > 75 /Mean age at enrolment: 42-73 /Tendency for NO2-effects and traffic loads to be larger in the older age group	+	+
Gan, Wen Qi et al.	2013	Age: 45-84, mean age: 59 /Interquartile range elevation in black carbon concentrations (0.97x 10(5)/m, equivalent to 0.78 µg/m³ EC was associated with a 6 % (95 % CI, 2-10 %) increase in COPD hospitalizations and a 7 % (0-13 %) increase in COPD mortality	+	+
Oliveira, Marcio Sacramento de et al.	2011	Age: > 65 /74.5 % of deaths were among the elderly. Increase in deaths from PM10 to lag 1 10.04 % (95 % CI: 0.90-20.02 % in elderly women. Increase in risk of deaths from PM10 to lag 9 was 10.80 % in elderly men. For exposure to SO2 and O3, the risk was significant in the elderly population	+	
Faustini, Annunziata et al.	2016	Age groups: 35-64; 65-74; 75-84; 85+/effects modification of short-term PM10-related mortality were seen in the people 85+ (3.10 %; p-interaction 0.043)	+	+
Troeger, Christopher et al.	2018	lower respiratory infections were a leading infectious cause of mortality worldwide in children < 5 years (652 572 deaths, 95 % UI 586 475–720 612) and in adults older >70 years (1 080 958 deaths, 943 749–1 170 638); the lower respiratory infection mortality rate, remained relatively constant in >70 between 2000 and 2016	0	+
Brüske, Irene et al.	2010	Age: 35-78, two age groups: <> 60 /Decrease of PMN and platelets within the first 24 hours associated with all particulate air pollution parameters, most for ACP. Effects stronger for people <60.	-	++
O'Neill, M. S.; Hajat, S. et al.	2005	Three age groups: all ages; 0-14; > 65 /Higher effects of mortality on those > 65 years, but similar to those of all-age mortality. Heat effect Monterrey 65+: 7.1 % (95 % CI: 3.9 %, 10.4 %). Heat effect in Mexico, 65+: Increase of 3.5 % (95 % CI: 0.3 %, 6.9 %). Cardiovascular mortality cold temperatures Mexico: 18.8 % excess among elderly (95 % CI; 9.0 %-14.5 %)	+	+
Martins, M. C. H. et al.	2004	Age: > 60 /A 10 qg/m3 increase in PM10, increase in mortality was between 1.4 (95 % CI 5.9-8.7) and 14.2 % (95 % CI 0.4-28.0). Overall increase over all regions was: 5.4 % (95 % CI 2.3-8.6)	+	
Tanaka, Takako et al.	2013	Age: > 65 /respiratory function declined significantly from 2000-2009 (p<0.01). Change in mean vital capacity was -40.5ml/year in males and -32.7 ml/year in females. Change in FEV1 was -27.6 ml/year in males and -23.9 ml/year in females	+	+
Palmer, K. T. et al.	2009	Age: 16-74 years, two groups - 16-64 years and 65-74 years; metal workers and infectious pneumonia; exposure to metal fume is cause of occupational mortality from pneumococcal and lobar pneumonia and from pneumonias; no excess from these causes at older ages	0	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Hao, Yongping et al.	2015	Age: >45 years, 15.5 % >65 years; 265223 subjects; increased risk of death due to CLRD associated with ozone was small compared with the risk posed by lifetime smoking, older age (>65 yr), and temperature.	+	+
Zanobetti, Antonella et al.	2008	Mean age: 76 /PM10 increase annual: HR 1.22 for the previous 4 years (95 % CI; 1.17-1.27) for mortality	+	+
Xue, Xiaoxia et al.	2018	Two age groups: <> 65; mean age: 78-80 /Death numbers increased with aging, respiratory deaths: 4.7 (95 % CI, 0.00-9.9), lung cancer: 6.5 % (95 % CI, 1.2-12.0), both associated with a 10 µg/m3 in PM2.5. People > 65 were more vulnerable to effects of O3 (on lag 02: OR=1.102, 95 % CI; 1.001-1.214)	+	+
Vodonos, Alina et al.	2016	Two age groups: all ages; > 65 /OR for people > 65 and PM10: 1.018 (1.005-1.031); PM2.5: 1.078 (1.032-1.127) for pneumonia increase associated with increase in 10 units of PM	+	++
Faustini, A. et al.	2011	Three age groups: > 35; > 65; > 85 /The mortality risk related to PM10 was higher in the age groups 75-84 and > 85 years (1.72 (95 % CI;-0.44-3.93) and 3.24 (95 % CI; 1.36-5.17). The increase of respiratory mortality was higher in summer.	+	+
Li, Guoxing et al.	2017	Two age groups: <> 75 /The average YLL of the elderly were higher than that of the young ones. (61+-30 vs. 19+-20). More daily deaths accounted in the older age group (9+-4 vs. 1+-1)	+	+
Sun, S et al.	2019	Age: > 65 /The effects of air pollution for cases rising in the warm climate were statistically significant (p<0.05). Increasing linear trend of urban climate modification on the association of pneumonia mortality with NO2 (NO2) ptrend=0.035)	+	

Ozon	**Morbidität**	J00-J99 Krankheiten des Atmungssystems	3

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Jung, Soon-Won et al.	2016	Age: 9-65 years; 2283 participants, 200 (9-14 years), 1419 (15-64 years), 664 (>65); forced vital capacity (FVC) and forced expiratory flow (FEV1) measured per 1 ppb ozone increase; comparison of four methods adults no significant effect found; >65 years old negative association FEV1 and ozone, 0-2 days lag -0.07 (-0.13, -0.01), adults not significant, children -0.10 (-0.16, -0.04); FVC not significant in elderly	0	+
Luong, Ly M. T. et al.	2018	Age: < 5 - > 65 years; no more details; general population; association of hospital admissions and ozone; stronger effect of ozone in winter on respiratory diseases, children more affected than other age groups in winter and summer; no significant association between wheeze-associated diseases and ozone	-	+
Magzamen, Sheryl et al.	2017	Age: 0 - > 85 years; 49.4 % over 65 years old; 104468 hospital admissions; association of respiratory-related hospital admissions and ozone levels; relative risk for a 10 ppb increase in ozone at 3 day lag increases; oldest age groups (64–84 years and 85+ years): increase in risk for respiratory-related hospital	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		admissions at 3 days' lag in Clark County (adjusted RR aged 65–84 years=1.05; 95 % CI: 1.02, 1.09; adjusted RR for adults, aged 85+ years=1.09, 95 % CI: 1.02, 1.17) and King County (RR aged 65–84 years=1.03; 95 % CI: 1.01, 1.05; adjusted RR aged 85+ years=1.05, 95 % CI: 1.02, 1.08). No increase in risk among adults, aged 15–44 years		

Stickstoffdioxid	**Morbidität**	J00-J99 Krankheiten des Atmungssystems	7

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Altzibar, J. M. et al.	2015	Mean age: 77 years (in the age group > 64 years). upward trend in hospitalization in > 64-year-olds especially in women; 4.2-fold more hospitalizations in women than men. In this age group, the female-to-male incidence ratio was 2.95: 1, with a peak at 77 years of age. The > 64year-old group accounted for just 8.4 % of the ED visits but, of these cases, 45.4 % were admitted. highest rate of visits was in 2-year-olds; Peaks in cases occur at the beginning of autumn in children and in winter in adults. AEs were correlated positively with exposure to NO2, CO and to the influenza virus and negatively with temperature and exposure to O3.	+	+
Andersen, Zorana Jovanovic et al.	2012	Mean age: 56 years; Long-term exposure to traffic-related air pollution increases the risk for asthma hospitalization in older people. Women were more often admitted to hospital for asthma; NO2 levels were associated with risk for asthma hospitalization in the full cohort (HR and 95 % CI per IQR, 5.8 mg/m3: 1.12; 1.04e1.22), and for first-ever admissions (1.10; 1.01-1.20), with the highest risk in people with a history of asthma (1.41; 1.15-2.07) or chronic obstructive pulmonary disease (COPD) (1.30; 1.07-1.52) hospitalization.	+	+
Andrea Rodriguez-Villamizar, Laura et al.	2018	various age groups: For NO2, PM10, and PM2.5, the multi-city models showed greater and statistically significant percentage increases in emergency department visits for respiratory diseases, particularly for the 5 to 9-year-old age group. These same pollutants also significantly affected the rate of emergency department visits for circulatory diseases, especially for the group of persons over 60 years of age.	+	+
Nuvolone, Daniela et al.	2011	various age groups: Among females, the elderly tended to live closer to the main road than younger people; females living within 100 m of the road tended to have lower socio-economic status and less passive smoking exposure and occupational exposure than females living farther away; females living within 100 m of the main road had increased adjusted risks for dyspnea (OR = 1.61, 95 % CI = 1.13-2.27), positivity to skin prick test (OR = 1.83, 95 % CI = 1.11-3.00), asthma diagnosis (OR = 1.68, 95 % CI = 0.97-2.88) and attacks of shortness of breath with wheeze (OR = 1.67, 95 % CI = 0.98-2.84)	+	++
Tam, P. Y. Iroh et al.	2017	Age: > 65 years; high and low number of individuals (the top 50 %, compared to the bottom 50 %, of the distribution of number of individuals aged ≥ 65 years) significant interaction	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		between air quality and age ≥ 65 years suggests that this group may be vulnerable to pneumonia hospitalization induced by poor air quality; Block groups with larger populations of adults ≥ 65 years had pneumonia hospitalization rates that were 40 % (IRR 1.40, 95 % CI [1.26, 1.56]) higher than the block groups containing smaller populations of older adults; adults ≥65 years who live in regions with second, third, and fourth quartiles of NO2 emissions had 68 % (IRR 1.68, 95 % CI [1.37, 2.06]), 58 % (IRR 1.58, 95 % CI [1.28, 1.96]) and 110 % (IRR 2.10, 95 % CI [1.64, 2.71]) higher risk for pneumonia hospitalization		
Wilson, Adam M. et al.	2005	various age groups: Elevated levels of SO2 and ozone were positively associated with elevated respiratory and asthmatic ER visits; IQR increase in SO2 levels was associated with a 5 % (95 % CI 2–7 %) increase in all respiratory visits and a 6 % (95 % CI 1–12 %) increase in asthma visits; all respiratory visits of people > 65 years old increased 4 % (95 % CI 3–11 %) in Manchester	0	++
Yamazaki, S. et al.	2014	of the 112 subjects, 76 (68 %) were aged < 15 years. no association between daily PM2.5 levels and primary care visits (PCVs) due to asthma attack at night; ozone is may be associated with PCVs.	-	++

Stickstoffdioxid	**Mortalität**	J00-J99 Krankheiten des Atmungssystems	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
César, A. C. G. et al.	2015	there were 385 deaths owing to respiratory diseases, with 90 % of these among elderly adults over 60 years old; Deaths were associated with exposure to PM2.5 in lags 0 and 1, to O3 in lags 2 and 4, and to NOx in lag 2 up to lag 5.	+	+
Ren, Meng et al.	2017	Two age groups: <65/>65 years: Strong evidence of an association between NO2 and daily respiratory disease mortality among men or people > 65 years was found in the case-crossover study. >65: SO2: OR CI 95 % 1.023 (1.005,1.041) for lag1 (P-value < 0.05) NO2: 1.028 (1.002,1.054)	+	+

VOCs	**Morbidität**	J00-J99 Krankheiten des Atmungssystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Bentayeb, Malek et al.	2013	higher risk of breathlessness in elderly exposed to indoor air pollution than in the rest of the exposed population with elevated concentrations of toluene and o-xylene. (adjusted odds ratios (AOR (95 % confidence interval) = 3.36(1.13, 9.98) and 2.85(1.06, 7.68) in elderly vs. 0.91(0.59, 1.39) and 0.79(0.47, 1.34) in the others respectively)	+	++

Feinstaub	**Morbidität**	K00-K93 Krankheiten des Verdauungssystems	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Tian, L. et al.	2017	age: > 65 /An IQR increment of 5-day moving average (lag_{04}) of NO_2 concentration (25·8 μg/m³) was associated with a 7·6 % (95 % CI 2·2–13·2) increase in emergency admissions for peptic ulcer bleeding	+	+
Wong, Chit-Ming et al.	2016	aged 65 years: Long-term exposures to PM2.5 were associated with PUD hospitalization in elder population: associations with PM2.5 significant for gastric ulcers (HR 1.29; 1.09–1.53, P¼0.003) but not for duodenal ulcers (HR 0.98; 0.78 to 1.22, P¼0.81)	+	+

Stickstoffdioxid	**Morbidität**	K00-K93 Krankheiten des Verdauungssystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Kaplan, Gilaad G. et al.	2010	Age: < 23; 44-57; > 58 years; Overall, NO2, SO2, and PM10 were not associated with the risk of IBD; Adults aged 44 – 57 years were less likely to develop Crohn ' s disease in regions of higher concentrations of NO2 and PM10; ≥ 58 Year: OR 1.28 (0.78 – 2.09), 1.10 (0.67 – 1.82)resp. <23 years: 2.31 (1.25 – 4.28) 1.73 (0.98 – 3.03)	-	+

Feinstaub	**Morbidität**	K00-K93 Krankheiten des Muskel-Skelett-Systems und des Bindegewebes	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Prada, D. et al.	2017	age: > 65 /risk of bone fracture admissions at osteoporosis-related sites was greater in areas with higher PM2·5 concentrations (risk ratio [RR] 1·041, 95 % CI 1·030 to 1·051).	+	
Alvaer, K. et al.	2007	Age: 75-76 years; 590 subjects; air pollution and bone mineral density; there was a weak but statistically significant inverse association between indicators of air pollution and total body bone mineral density; no significant association was found for total hip BMD	0	+
Alver, K. et al.	2010	Age: two groups - 59/60 years and 75/76 years; 5976 subjects; air pollution and bone density; association between long-term outdoor air pollution exposure and bone health was suggested in men aged 75/76 years, but not in younger men or in women	+	++
Theppeang, Keson et al.	2008	Age: 50-70 years, mean age 59; 112 subjects; bone mineral density (BMD) and lead in blood, tibia and patella; higher tibia lead levels were associated with higher BMD; lead can be stored in bones and is released with increasing age, leading to higher risk from long-term past exposure of lead in older women	+	++

Schwermetalle	**Morbidität**	M00-M99 Krankheiten des Muskel-Skelett-Systems und des Bindegewebes	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Kim, Yong-Dae et al.	2014	Age: > 30 years, mean age 63.8 years; 1086 subjects; cadmium-induced renal tubular damage and osteoporosis; Cd levels higher in females than males; positive correlation between the proportion of creatine and urinary Cd level was found; in female subjects, increased Cd body burden first induces renal microtubular damage and then leads to osteoporosis	+	+
Garcia-Esquinas, Esther et al.	2015	Age: > 60 years; 5579 subjects; blood lead but not urine cadmium concentrations showed a direct dose-response relationship with frailty in older adult population	+	+

Stickstoffdioxid	**Gesundheitsinfrastruktur**	M00-M99 Krankheiten des Muskel-Skelett-Systems und des Bindegewebes	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Mazzucchelli, R. et al.	2018	Two age groups: <> 75 years; Hip fracture incidence showed association with: SO2 (IRR 1.11 (95 % CI 1.04–1.18)), NO (IRR 1.01 (95 % CI 1.01– 1.02)), and NO2 (IRR 1.02 (95 % CI 1.01– 1.04); ozone (IRR 0.97 (95 % CI 0.95–0.99); impacts of the air pollutants were observed in men, women, and in > 75 years, and this association was not observed in <75 years	+	++

Feinstaub	**Morbidität**	N00-N99 Krankheiten des Urogenitalsystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Yang, Ya-Ru et al.	2017	Two age groups: <> 65, mean age: 53 /association only in persons <65; An IQR-increase in PM10 (5.83 µg/m3) was negatively associated with eGFR ba -0.69 (95 % CI: -0.89, -0.48) mL/min/1.73 m^2 and positively associated with lower eGFR by -1.07 and CKD with OR=1.26;	+	+++

Schwermetalle	**Mortalität**	N00-N99 Krankheiten des Urogenitalsystems	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Lin, Ja-Liang et al.	2011	Age: 18-93 years; mean age 55-56; 927 subjects; blood lead levels and mortality on maintenance hemodialysis; high blood lead level is associated with increased risk for all-cause, cardiovascular-cause. And infection-cause mortality in patients on maintenance hemodialysis	+	+++

Stickstoffdioxid	**Mortalität**	S00-T98 Verletzungen, Vergiftungen und bestimmte andere Folgen äußerer Ursachen	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Ha, Kyoung Hwa et al.	2015	various age groups: the cases assessed were more likely to be male (67.2 %) and relatively older, with a large percentage (49.7 %) aged 60 years or older; SO2, NO2, and CO (PM10 was not) were found to be significantly associated with increased risk of unintentional injury deaths in lag 1; OR >60: SO2 1.077 (1.009–1.150) NO2 1.162 (1.027–1.315) O3 0.989 (0.953–1.026) PM10 1.016 (0.971–1.063) CO 1.016 (1.004–1.028)	+	+

Feinstaub	**Morbidität**	R00-R99 Symptome und abnorme klinische und Laborbefunde, die anderenorts nicht klassifiziert sind	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Ng, Chris Fook Sheng et al.	2016	Three age groups: < 30; 30-60; > 60. 32 % of study population were > 60 years old. Higher risk of suicide in the age group > 60, when women are widows.	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		Increased risk of suicide among widowed subjects (10.55 %, 95 % CI: 2.05 %-19.75 %) and persons <30 for NO		
Kim, Changsoo et al.	2010	Three age groups: < 35; 36-64; > 65 /age > 65: 651 men (21.7 %) and 404 (30.1 %) women committed suicide. Suicide risk of oldest age group associated with PM was quite low. A high proportion were in the age range of 36–64 years or were of low socioeconomic status.	-	+

Stickstoffdioxid	**Morbidität**	Sonstige	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Brunt, H. et al.	2016	Various age groups; Air pollution concentrations were highest in 'most' deprived areas. Separately, deprivation–health associations were stronger than air pollution–health associations; 'most deprived' areas contained the highest proportion of children aged <15 years in any deprivation quintile (24 %; estimated population: 122 458); 'least' deprived areas had high air pollution concentrations and contained the highest proportion of older people aged 75+ years in any deprivation quintile (23 %; estimated population: 57 332)	-	+
Cesaroni, Giulia et al.	2010	Elderly people > 75 years and those living in areas of high and medium SEP tend to be more exposed. living <50 m near high traffic roads HTR OR: >75: 1.41 (1.35 - 1.48) 65-74: 1.24 (1.19 - 1.29) 35-64: 1.10 (1.08 - 1.13) 18-34: 1.09 (1.06 - 1.11)	+	++
Bai, Yang et al.	2018	Age: 58-76 years; quasi-experimental setting with older people: Each 10 µg/m3 increment in NO2 exposure during the last 5 days was associated with 0.07 µm2 (95 % CI: 0.001 to 0.012) increase in median area of airway macrophages black carbon; A 10 µg/m3 increase in NO2 was associated with 3.9 % (95 % CI: 2.2 to 5.5 %) decrease in mtDNAcn.	+	+

Schwermetalle	**Morbidität**	Sonstige	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Kim, Kyoung-Nam et al.	2017	Age: 41-71 years, mean age 55, 33.9 % > 60; 386 subjects; blood lead and homocysteine and gene polymorphisms; Blood lead concentrations were positively associated with plasma homocysteine levels, homocysteine levels were higher in the elderly, men, alcohol drinkers and tobacco smokers	+	+++

Feinstaub	**Morbidität**	Sonstige	6

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Santovito, Alfredo et al.	2016	Older people (51-65) showed significantly higher levels of genomic damage than younger individuals	+	+++
Weuve, Jennifer et al.	2016	Age: >65 years, mean 75 years; 5708 subjects; traffic-related air pollution and progression in physical disability; long-term NOx exposure associated with significant faster progression in disability	+	+
Resnick, Adam et al.	2015	Two age groups: 20-64; > 65 /For older people > 65: Increased risk of ED visits. For Asthma: RR: 1.73, 95 % CI = 1.03-2.93. For diseases of the veins, lymphatic and circulatory system: RR: 1.56, 95 % CI = 1.00-2.43	+	+
Pongpiachan, Siwatt et al.	2015	Age groups: 15-59; 60-74; > 75 /Male IPD-numbers were significantly higher than those of females (among others 60-74). For age group 75+: no significant difference between male and female /No significant differences in Male and female-OPD in age group 60-74; 75+	+	+
Hertel, Sabine et al.	2010	Age: 45-75, mean age: 59 //>60 years and overweight participants showed slightly higher increases in hs-CRP than younger or non-overweight participants for all averaging times; A positive association between PN and hs-CRP could be observed only for single day lags and for averaged PN concentrations with higher estimates for longer averaging times. Highest hs-CRP-increase of 7.1 % (95 % CI: 1.9, 12.6 %) in the 21-day average	+	++
Wong, Jason Y. Y et al.	2018	Age: >65 years; 933 subjects; air pollution and chromosome Y loss; PM10 may increase leukocyte mosaic loss of chromosome Y (mLOY), a marker of genomic instability	+	+

Feinstaub	**Mortalität**	Sonstige	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Wen, Ming et al.	2012	Age: 65-99; Mean age women: 73; mean age men: 71, 72 /Exposure to air pollution (outdoor) corresponded to subsequent reductions of life expectancy and Hes. Women are more vulnerable than men	+	++
Zeng, Qiang et al.	2017	Two age groups: <> 65 /The association between PM10 and non-accidental deaths and YLL among the elderly were stronger than those among the younger ones.	+	+

Feinstaub	**Gesundheitsinfrastruktur**	Diverse: Krankheiten des Kreislauf und des Atmungssystems	14

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Fung, K. Y et al.	2005	Two age groups: < > 65 /asthma admissions (> 65): significantly associated with PM10, percentage	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		increase in cardiac admission of 25 % (95 % CI: 2.8-52.3) and 26.0 % (95 % CI: 5.3-50.9 %) for current day and 2-day means		
Phung, Dung et al.	2016	Two age groups: 5-65; > 65 /A significant association between PM10 and the risk of CVD admissions for the 65+ (RR, 1.008, 95 % CI, 1.001-1.01). NO2 and CVD admissions were also significant: RR, 1.04, 95 % CI, 1.01-1.06)	0	+
Carugno, Michele et al.	2016	Age classes: < 65; 65-74; > 75 /The effect of PM10 on respiratory hospital admissions appeared to increase with age (1.64 %, 90 % CI: 0.35; 2.93)	+	+
Powell, H et al.	2015	Two age categories: 65-74; > 75 /For both: a 10-µg/m3 increase in >PM>10-2.5 was associated with a significant increase in same-day cardiovascular hospitalizations [0.69; 95 % PI: 0.45, 0.92]	+	
Bell, Michelle L et al.	2015	Age: > 65 /point estimates: higher for women than men for almost all causes of hospitalization. PM2.5: higher risk for women for respiratory tract infections, cardiovascular and heart rhythm disturbance admissions. 10 µg/m3 increase in PM2.5: 1.13 % increased risk of heart rhythm disturbance admissions for women (95 % posterior interval: 0.63 %, 1.63 %), and 0.03 % for men (95 % PI:-0.48 %, 0.55 %)	+	
Samoli, Evangelia et al.	2016	Two age groups: 0-14; 15-64 /Average of past 7 days EC/BC exposure was associated with elderly (+65) cardiovascular admissions	+	+
Ferreira, Tatiane Morais et al.	2016	Age >60; 2737 subjects; PM and hospital admissions in elderly; association between PM and increased hospital admissions in elderly residents for respiratory diseases and circulatory diseases	+	
Dominici, F et al.	2006	Age: >65 years; PM and hospital admission for cardiovascular and respiratory diseases; short-term increases in hospital admission rates associated with PM2.5 for all of the health outcomes	+	
Bell, Michelle L et al.	2009	Age: > 65; short-term effects of PM2.5 on cardiovascular and respiratory hopitalizations and county-specific levels of vanadium, elemental carbon or nickel PM2.5 content	+	
Halonen, Jaana I. et al.	2016	Two age groups: 45-74; > 75. Linear admissions close to unity among the elderly. Among the elderly > 65 years, nearly all effect estimates for all respiratory admissions were slightly below one	0	+
Linares, C et al.	2010	Age: > 75 /PM2.5 was significant for all models. The RRs for an increase of 10 mg/m3 in PM2.5 were: 1.038 [95 % CI; 1.022-1.053] for all causes at lag 0. 1.062 (95 % CI; 1.036-1.089) for circulatory causes at lag 0;	+	

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		and 1.049 (95 % CI 1.019-1.078) for respiratory causes at lag 3. The ARs were: 3.6 %, 5.9 % and 4.6 %		
Andersen, Z. J et al.	2008	adverse health effects of PM on CVD and RD hospital admissions in the elderly (>65)	+	+
Liu, S.-T et al.	2017	Two age groups: < > 65 /For those > 65: A 10 g/m3 increase in PM2.5 from ADS was significantly associated with an increase in ER visits (CVD): OR: 2.77, CI 95 %, p<0.05 /For the respiratory diseases: OR: 3.94, 95 % CI, p<0.05	+	+
Liu, Jia Coco et al.	2017	Short-term exposure to wildfire-specific PM2.5 was associated with risk of respiratory diseases in the elderly population	+	+

Feinstaub	**Gesundheitsinfrastruktur**	Diverse	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Zanobetti, Antonella et al.	2014	Age: > 65 /short-term exposure to PM2.5 is significantly associated with an increase in hospitalization risks for diabetes (1.14 % increase,) % % CI: 0.56, 1.73 for a 10 µg/m3 increase in the 2 days average. Parkinson: 3.23 %, 1.08, 5.43. Also Increase in all-vause-mortality risks: 0.64 %, 95 % CI: 0.42, 0.85)	+	
Di Ciaula, Agostino	2012	Age: > 70; positive correlation in elderly between the number of emergency visits and daily air concentrations of PM10 and NO2. In subjects 70+: Number of hospital admissions was positively correlated with PM10 levels (within 3km of plant). Subjects 80+: also linked with the lowest air concentration of PM10 (6km of plant)	+	+

Feinstaub	**Morbidität**	Diverse: Krankheiten des Kreislauf und des Atmungssystems	7

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Sullivan, Jeffrey H. et al.	2007	Median age: 77-80 /No statistically significant effect of a same day 10 ug/m3 increase in fine PM on (log.) levels of CRP 1.21 fold-rise (95 % CI: 0.86, 1.70), fibrinogen 1.02 fold-rise (95 % CI: 0.98, 1.06). Or D-dimer 1.02 fold-rise (95 % CI: 0.88, 1.17) in individuals with CVD	+	+
Zhang, Zili et al.	2016	Age: 60-70 /For D-dimer and platelet number, statistically significant increases associated with increases in NO2 at lag 1–3 and SO2 at lag 2–4 were observed.	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
To, Teresa et al.	2015	Age groups at entry: 40-44; 45-49; 50-54; 55-59, mean age follow up: 77 /Congestive heart failure (PR=1.31, 95 % CI: 1.13, 1.51), diabetes (PR=1.28, 95 % CI: 1.16, 1.41), ischemic heart disease (PR = 1.22, 95 % CI: 1.14, 1.30), and stroke (PR = 1.21, 95 % CI: 1.09, 1.35) showed over a 20 % increase in PRs per 10 µg/m3 increase in PM2.5 after adjusting for risk factors.	+	++
Bertoldi, Martina et al.	2012	Three age groups: 0-14, 34 -64; > 65; 22721 subjects; air pollution and health effects; Stronger association between hospital admissions and air pollution for people < 65. AR <64: 34.18 %; AR > 65: 5.26 %	-	++
Merrifield, A et al.	2013	Age: 0->65 years, 12 % over 65; general population; dust storm associated with increases in asthma emergency department visits, and respiratory emergency department visits; no significant increase in cardiovascular emergency visits or hospital admissions for any reason; all-cause and respiratory emergency department visits in the >65 year age group increased	+	+
Karottki, Dorina Gabriela et al.	2015	Age: 51-81, mean age: 67 /Significant associations were: MVF with dust bacteria; Monocyte expression of CD11 with PM2.5 in the bedroom and dust bacteria and endotoxin, CD31 expression with dust serine protease; serum CC16 with dust NAGase	+	+

Feinstaub	**Morbidität**	Diverse	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Zeng, Yi et al.	2010	Mean age: 86 /Air pollution increased the odds of disability in activities of daily living (ADLs), cognitive impairment and health deficits.	+	+

Feinstaub	**Mortalität**	Diverse: Krankheiten des Kreislauf und des Atmungssystems	49

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Chan, Chang-Chuan et al.	2011	Two age groups: <65 /> 65; For people > 65: Excess deaths were increased significantly for residents above 65 years: OR=1.025 (95 % CI 1.006-1.044) for non-accidental deaths and OR=1.045 (95 % CI, 1.0011-1.081), not significant for respiratory deaths	+	+
Yang, C et al.	2012	Two age groups: <> 65. Ambient PM 2.5 was associated with mortality from all causes and cardiorespiratory diseases. An increase of 10 lg/m3 in 2-day moving average (lag01) concentration of PM2.5 corresponds to 0.90 % (95 % CI: 0.55, 1.26 % increase of total mortality, 1.22 % (95 % CI: 0.63, 1.68 %) increase of cardiovascular mortality, and 0.97 % CI:	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		0.16, 1.79 %) increase of respiratory mortality. Stronger associations for the elderly		
Lee, Mihye et al.	2016	Mean age: 73 / a 10 µg/m3 increase in PM2.5 (mean lag0 and lag1) was associated with a 1.56 % (1.19, 1.94) increase in daily deaths. Cardiovascular disease (2.32 %, 1.57–3.07) showed the highest effect estimate.	+	
Samoli, Evangelia et al.	2008	Two age groups: < > 75 years /increase of 10 µg/m3 PM10 means daily increase in deaths by 0.84 % (95 % CI, 0.30-1.40 %) for Canada, 0.33 % (95 % CI, 0.22-0.44 %) for Europe and 0.29 (95 % CI, 0.18-0.40 %) for US. Larger effects for people > 75. Air pollution estimates were higher for older people > 75. Higher effects of PM10 on cardiovascular mortality for people > 75: 1.30 % for Canada (95 % CI, 0.19-2.40 %), 0.47 % (95 % CI, 0.23-0.70 %) for Europe and 0.51 % (95 %CI, 0.29-0.73 %) for USA. Larger respiratory mortality for elderly	+	+
Zanobetti, Antonella et al.	2006	Age groups: 65-75; > 75 /Significant association between NO2 (12.7 % change (95 % CI: 5.8, 18)), PM2.5 (8.6 % increase (95 % CI: 1.2, 15.4)), and BC (8.3 % increase (95 % CI: 0.2, 15.8)) and the risk of myocardial infarction hospitalisation: Risk of pneumonia hospitalisation and BC: 11.7 % increase (95 % CI: 4.8, 17.4)), PM2.5 (6.5 % increase (95 % CI: 1.1, 11.4)), and CO (5.5 % increase (95 % CI: 1.1, 9.5))	+	+
O'Neill, Marie S.; et al.	2008	Age: > 21 /Effects of a 10-g/m3 increment in lag 1 PM10 in all nonexternal-cause adult mortality. Mexico City: 0.39 %; Sao Paulo: 1.04 %, Santiago: 0.61 %. Lag 1 for all people > 65: 0.50; 1.09; 0.84; associations did not differ consistently by educational level.	0	+
Fischer, Paul H et al.	2015	Age groups (relevant): 50-60; 60-70; 70-80; > 80 /Tendency for lower HRs in the older age category (> 65); no clear evidence of modification by socioeconomic status	-	+
Qiu, Hong et al.	2015	Two age categories:: <> 65 /10 qg/m3 increase of pollution: people > 65 had a 0.9-1.8 % additional increase in mortality related to PM, NO2 and SO2.	+	++
Roberts, S et al.	2006	Three age groups: <65; 65-74; > 75 /10 mg/m3 increase in PM was associated with a 0.12 % increase in total mortality and a 0.17 % increase in cardiovascular as well as respiratory mortality.	+	+
Kashima, Saori et al.	2012	Age: > 65 /Asian dust did not modify the effects of SPM on mortality. Excess risk following a 10 µg/m3 increase was 0.6 (95 % CI, 0.1-1.1) for heart disease, 0.8 (95 % CI, 0.1-1.6) for ischaemic heart disease, 2.1 (95 % CI, 0.3-3.9 for arrhytmia and 0.5 (95 % CI 0.2-0.8 for pneumonia mortality	0	

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Zúñiga, Julio et al.	2016	Age groups: < 65; 65-74; 75-84; > 84 /Levels of PM10, O3, NO2 were associated with increases in cardiovascular, respiratory, and diabetes mortality. (cardiovascular: 9.7 % (CI 5.8-13.6 %); respiratory: 12.6 %, O3: 32.45, NO2: 11.2 %	+	+
Liang, Wen-Miin et al.	2009	Two age groups: 65; > 65 /Risk of death from cardiovascular diseases during winter was significantly positively correlated with levels of SO2, CO, and NO2 for both groups of subjects and additionally with PM10 for the elderly. Significant positive correlation: O3 for the elderly during summer (RR=1.283)	+	+
Franklin, Meredith et al.	2007	age: <> 75 /Mortality > 75: greater effects in subjects >75; all-cause: 0.62 % (-0.30, 1.55); respiratory: 1.53 % (-0.67, 3.74); cardiovascular: 0.26 % (-1.04, 1.56); Stroke: -0.78 % (-2.32, 0.76) all 95 % CI; that women may be more susceptible to PM2.5 effects than men	+	+
Alessandrini, Ester Rita et al.	2016	Age: 65–74, 75–84, and ≥85 years /PM 2.5: positively associated with natural mortality (1.05 % and 0.74 % increases in mortality risk for increments of 10 µg/m3 and 14.4 µg/m3, respectively) greater effects among older people /Limited associations among people with no previous hospital admission: Diabetes (1.98 %, 95 % CI: 0.54, 3.44) and cardiac arrhythmia (1.65 %, 95 % CI: 0.37, 2.95) increased risk of PM2.5-related mortality, while heart conduction disorders increased risk of mortality related to both PM2.5 (4.22 %, 95 % CI: 0.15, 8.46) and PM10 (4.19 %, 95 % CI: 0.38, 8.14)	+	+
Qian, Zhengmin et al.	2007	age: <> 65 /PM10/mortality: Lag 0 day: people > 65 years had a mean change of 0.41 % for non-accidental mortality. Cardiovascular: 0.57. Stroke: 0.49. Cardiac: 0.49. Respiratory: 0.79. Cardiopulmonary: 0.53, all 95 % CI. Stronger effects than for younger people	-	+
Garcia, Cynthia A et al.	2016	age: > 65 /Cardiovascular disease (CVD), ischemic heart disease (IHD), and cardiopulmonary disease (CPD), mortality was significantly associated with rural, urban, and statewide chronic PM2.5 exposures. PM2.5 was significantly associated with AC mortality in rural areas and statewide;	+	
Chen, Renjie et al.	2012	Three age groups: 0-4; 5-64; > 65 /Females, older people, and residents with low educational attainment appeared to be more vulnerable to PM10 exposure: 10-lg/m3 Increase in PM10/a -> 0.50 % increase in total mortality (95 % PI, 0.22, 0.78)	+	+
Yorifuji, Takashi et al.	2016	Age: > 65 /Same-day PM2.5 and PM 7,2.5 were independently associated with all-cause and cause-	+	

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		specific mortality related to cardiovascular and respiratory disease: increased risk of all-cause mortality: OR 1.006 (95 % CI: 1.003, 1.009) for PM2.5 and 1.016 (95 % CI: 1.011, 1.022) for PM 7-2.5		
Ostro, Bart et al.	2015	Mean age: 57 /Significant association of IHD with PM2.5 mass, nitrate, EC, copper and secondary organics and the sources gas- and diesel-fueled vehicles, meat cooking, and high sulfur fuel combustion. HR: 1.19 (95 % CI: 1.08, 1.31) for IHD in association with a 10 µg/m3 increase in PM2.5	+	+
Nunes, Karine Vila Real et al.	2013	Age groups: 65-69; 70-74; 75-79; 80+ /Correlation between annual % of exposure hours to PM2.5 varied between 0 and 44 %. The correlation between PM2.5 and cardiovascular and acute myocardial infarction mortality rates (33 % & 39 %) is significant. Significant association between exposure and cardiovascular disease mortality rates in all age groups > 65 years, varying between 0.62-4.1	+	+
Klemm, R. J. et al.	2004	Three age groups: all ages, <> 65 /CO, NO2, PM2.5, CM, SO2, O3, EC, OC, best model fits for all-cause mortality 65+	+	++
Geng, Fuhai et al.	2013	Age groups: 0-4; 5-44; 45-64; 65+ /Percentage increase of daily mortality associated with an IQR increase in BC concentrations: 65+: 103.7 daily deaths, 2.9, 95 % CI; 1.0; 1.47. For 65+: < 65 years old, the effects were not statistically significant; while for older urban residents >65, black carbon was found to be positively associated with increased death risk.	+	+
Samoli, Evangelia et al.	2011	Two age groups: <> 75 /A 10µg/m3 increase in PM10 was associated with a 0.71 % (95 % CI: 0.42 %-0.99 %) increase in all deaths. Effects for total and specific mortality were greater for the people > 75 (1.05 %, 95 % CI; 0.60 %-1.50 %) for cardiovascular and 1.07 % (95 % CI: 0.14 %-2.01 %) for respiratory mortality	+	+
Kollanus, Virpi et al.	2016	Age <65 and >65 years, no more details; 165259 subjects; PM2.5 and daily mortality; increase in PM2.5 was associated with a borderline statistically significant increase in cardiovascular mortality among total population at a lag of three days, and among elderly (>65) following same-day exposure and at a lag of three days	+	+
Ma, Yanjun et al.	2011	Age: mean age 67, 3 age groups - 5-64, 65-74, >75; 60938 subjects; increases of PM2.5 corresponds to increases of total cardiovascular and respiratory mortality; association appeared stronger in older people (>75 years)	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Analitis, Antonis et al.	2012	Cardiovascular effects are larger in those aged <75 years, while respiratory effects are larger in older people	+	+
Pinheiro, Samya de Lara Lins de Araujo et al.	2014	Age: > 60 /10 µg/m3 increase in PM10 was associated with RR of cardiovascular and respiratory mortality of 0.85 % (0.45; 1.25) and 1.60 % (0.74; 2.46)	+	
Yorifuji, Takashi et al.	2010	Age: 65-84 years, mean age 74 years; 8412 subjects; air pollution and mortality; long-term exposure to traffic-related air pollution (NO2) increases risk of cardiopulmonary mortality, and the risk of lung cancer mortality in non-smokers	+	
Yorifuji, Takashi et al.	2013	Age: 65-84 years, mean age 74 years; 13412 subjects; traffic-related air pollution and hemorrhagic stroke and lung cancer; positive association of NO2 with all-cause, cardiopulmonary disease and lung cancer mortality	+	+
Pun, Vivian C et al.	2017	Age: 65-120 years; 18.9 million; air pollution and respiratory, cancer and cardiovascular mortality; positive association found for PM2.5 with respiratory, chronic obstructive pulmonary disease, and pneumonia mortality, cardiovascular and lung cancer mortality	+	
Wang, Yu-Chun et al.	2015	Age: two groups - all ages and elderly (>65 years); general population; air pollution by sand storms and mortality; increase in PM10 was associated with increased all-cause mortality risk for the total population and for elders; increase in PM2.5 related to increased mortality from circulatory diseases for the elderly	+	+
Kioumourtzoglou, Marianthi-Anna et al.	2016	Age: >65 years; 35 Mio, medicare enrollees; air pollution and mortality; association found between long-term PM2.5 and survival; association stronger in warm cities	+	
Kioumourtzoglou, Marianthi-Anna et al.	2015	Age: > 65, mean age: 75 /Positive associations between long-term exposure to PM2.5 and mortality with a HR of 1.11 % (95 % CI=1.01-1.23) per 10 µg/m3 increase in annual PM2.5 concentrations	+	
Jiménez, E et al.	2010	Age: > 75 /No significant association for PM10 and PM10-2.5. RR for a 10 µg/m3 increase in PM2.5 concentrations were: 1.032 (1.010-1.036) for total organic causes; 1.033 (1.031-1.035) for circulatory causes; and 1.032 (1.004-1.059) for respiratory causes	-	
Zauli Sajani, Stefano et al.	2011	Age: > 75 /Evidence for increased respiratory mortality was found on SDD. Respiratory mortality increased by 22.0 % (95 % CI 4.0 %-43.1 %) on the SDD in the whole years model and by 33.9 % (8.4 %-65.4 %) for whole season. Effects for natural and	+	

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		cardiovascular mortality substantially attenuated with ORs of 1.042 (95 % CI 0.992-1.095) and 1.043 (95 % CI 0.969 - 1.122)		
Wong, Chit Ming et al.	2015	Age: > 65, mean age: 71 /Mortality HRs for a 10-µg/m3 increase in PM2.5 were 1.14 (95 % CI: 1.07, 1.22) for all natural causes, 1.22 (95 % CI: 1.08, 1.39) for cardiovascular causes, 1.42 (95 % CI: 1.16, 1.73) for IHD, 1.24 (95 % CI: 1.00, 1.53) for cerebrovascular disease, and 1.05 (95 % CI: 0.90, 1.22) for respiratory causes	+	
Huang, Wei et al.	2012	Three age groups: 0-44; 45-64; > 65 /Greater mortality risk within the elderly.: RR 0.18 (95 % CI; 0.03, 0.34) per Per 10 mg/m3 increase in PM2.5. RR was 2.09 per IQR (95 % CI; 0.35, 3.85)	+	+
Jimenez, E. et al.	2009	Age: > 75 /The association between daily PM2.5 concentrations and all-cause mortality in Madrid was significant, but not in evidence for PM10. The RR for an increase of 25 µg/m3 in PM2.5 concentrations were: all-cause mortality: 1.057 (1.025-1.088); circulatory-cause mortality: 1.088 (1.041-1.135); and respiratory-cause mortality: 1.122 (1.056-1.189). Attributable risks: 5.41 %, 8.12 % and 10.90 %	+	
Kim, Satbyul Estella et al.	2015	Two age groups: <> 65 /For people > 65: Highest overall risk between PM10 and non-accidental or cardiovascular mortality was observed on very hot days and not extremely hot days. Strong effects of PM10 and mortality with the highest temperature range in men and very high temperature range in women	+	+
Stojic, Svetlana Stanisic et al.	2016	Age: > 65 /Risk of circulatory and respiratory mortality associated with cold temperatures decreased from 8.80 % to 3.00 % after accounting the cumulative effects of air pollutants.	0	
Wu, Rongshan et al.	2018	Age > 65: Stronger associations observed for ambient PM on cardio-respiratory mortality	+	
Yang, Yang et al.	2013	Four age groups: 0-4; 5-44; 45-64; > 65 /Effects of air pollutants were statistically significant in residents aged 65 years and older for nonaccidental and cardiovascular mortalities (CO: IQR increase: 2.70; NO2: 2.71; PM10: 1.82)	+	+
Ostro, B et al.	2007	Age: > 65 /Stronger associations were observed with mortality and in the age group > 65	+	+
Tsai, Shang-Shyue et al.	2014	Mean age: 74-80 years /association PM2.5 and total mortality: IQR increase with a 7 % (95 % CI, 3-11 %) and 6 % (95 % CI, 3-10 %) rise in total death numbers. Effect PM2.5 on risk of cardiovascular deaths: only on cold days: 7 % increase for each IQR range change; 95 % CI, 1-15 %	+	

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Tian, Lin et al.	2018	Two age groups: <> 65 /the effect estimates per 10 mg m3 increase in PM10 for non-accidental, cardiovascular and respiratory mortality increased 0.14 % (95 %CI: 0.05, 0.22), 0.12 % (95 % CI: 0.02, 0.23) and 0.14 % (95 % CI: 0.06, 0.34) when the temperature was low and 0.24 % (95 % CI: 0.12, 0.35), 0.17 % (95 % CI: 0.01, 0.34) and 0.45 % (95 % CI: 0.13, 0.78) at the high temperature level, The PM10 effects were stronger at the high temperature level for females and elderly people.	+	+
Vichit-Vadakan, Nuntavarn et al.	2008	Age groups: <5; 4-44: 18-50; 45-64; > 50; > 65; > 70 /The excess risk for non-accidental mortality was higher for people older than 65 years: 1.9 % (95 % CI; 0.8-3.0), same as cardiovascular mortality risk for older people: 1.5 % (95 % CI, 0.9-2.1)	+	+
Delfino, R. J. et al.	2009	Age: 0-99 years, 44 % over 65 years; people over 65 years had the strongest wildfire related PM2.5 associations with respiratory admissions	+	+
Fischer, P et al.	2003	Age groups: <45; 45.64; 65-74; > 75 /significant associations for mortality were mostly found in the elderly > 65 for the pollutants PM10, BS, SO2, NO2 and CO.	+	+
Wu, Rongshan et al.	2018	Age > 65: Stronger associations observed for ambient PM on cardio-respiratory mortality	+	

Feinstaub	**Mortalität**	Diverse	27

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Bell, Michelle L. et al.	2009	Age: > 65 / Each additional 20 % of households with central AC was associated with a 43 % decrease in PM2.5 effects on cardiovascular hospiltalization	+	
Cakmak, Sabit et al.	2007	very elderly are particularly susceptible to dying from air pollution: percent change in mortality was 2- to 3-fold greater for those at least 85 years of age compared to those < 65 years of age (t-test, p < 0.05 for PM10, SO2, and CO)	+	+
Li, Tiantian et al.	2018	Age: 65-116, median age at enrolment: 79 /Overall HR for a 10 µg/m^3 increase of PM2.5 was 1.08 (95 % CI, 1.06-1.09)	+	
Thurston, George D et al.	2016	Age: 50-71 /Significant association between PM2.5 and total mortality: HR=1.03; 95 % CI: 1.00, 1.05) and CVD mortality: HR=1.10; 95 % CI: 1.05, 1.15)	+	+
Kashima, Saori et al.	2016	Age: > 65 /10 µg/m3 increase of Asian Dust was significantly associated with an elevated pooled risk of all-cause mortality (RR: 1.003 [95 % CI: 1.001-	+	

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		1.005] lag 0; 1.001 at lag 1 and RR: 1.006 cerebrovascular disease at lag 1		
Di, Qian et al.	2017	age groups: < 69, 70-74, 75-84, > 85 /Each short-term increase of 10 µg/m3 in PM2.5 and 10 ppb in warm-season ozone were statistically significantly associated with a relative increase of 1.05 % (95 % confidence interval]: 0.95 %, 1.15 %) and 0.51 % (95 % CI: 0.41 %, 0.61 %) in daily mortality rate,	+	+
Goldberg, Mark S et al.	2013	age: > 65 /Positive association between daily non-accidental mortality and all air pollutants but O3. Daily mortality: 1.90 % (95 % CI: 0.73, 3.08 %) for an increase of the interquartile range (17.56 µgm−3 NO2)	+	
Samoli, Evangelia	2013	Two age groups: <> 75 /Stronger effects among the persons > 75. A 10-µg/m3 increase in PM2.5 was associated with a 0.77 % increase (0.43, 1.10, 95 % CI, p-value for interaction: 0.02) in all cause mortality for those > 75. PM2.5-10: 0.10 (-0.47, 0.68, 95 % CI, p-value for interaction: 0.16). PM10: 0.40 (0.17, 0.63, 95 % CI, pvalue: 0.24)	+	+
Pinault, Lauren L. et al.	2017	Age groups: 25-29; 30-39; 40-49; 50-59; 60-69; 70-79; 80-89 /majority of deaths occurred among the older population, but not necessarily linked to air pollution. But higher PM2.5 exposure levels in the older age groups: 60-69: 2.64 /70-79: 2.68 /80-89: 2.68	+	++
Ueda, Kayo et al.	2016	Age: > 65 /In a multi-pollutant model, an interquartile range increase in the concentration of sulfate was marginally associated with an increase in all-cause mortality of 2.1 % (95 % CI, -0.1-4.4)	+	
Strak, Maciej et al.	2017	age groups: 19-39; 40-63; >65 /Pollutants for the age groups > 65: Bias (P95-P5): 0.097 for NO2, HR: 1.102 (lung cancer); PM2.5 (lung cancer) 0.055 Bias, HR: 1.056; NO2 for cardiovascular disease: 0.028 for Bias, 1.028 for HR; PM2.5 for cardiovascular diseases: 0.016 for Bias, 1.016 for HR	+	+
Chung, Yeonseung et al.	2015	Age: > 65 /One-standard deviation (SD) increases in 7-years average EC, Si and NO3 concentrations were associated with 1.3 % (95 % PI: 0.3, 2.2), 1.4 % (95 % PI: 0.6, 2.4) and 1.2 % (95 % PI: 0.4, 2.1) increases in monthly mortality.	+	
Filleul, Laurent et al.	2004	Two age groups: All ages; > 65 /significant association between air pollution and all nonaccidental mortality and specific mortality. Greater effect among the elderly, with an estimated increase of 9.2 % in the daily number of deaths for 10mg/m3 of daily black smoke (95 % CI; 3.4-15.3)	+	+
Filleul, Laurent et al.	2004	Age: > 65: medians of age of death were 83.9 years for all non accidental causes and 84.5 years for	+	

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		cardiorespiratory causes; association between the third lag day and all nonaccidental mortality (OR ≙ 1.19; 95 % CI ≙ 0.99–1.43), significant for cardiorespiratory mortality (OR ≙ 1.30; 95 % CI ≙ 1.01–1.68)		
Blanco-Becerra, Luis Camilo et al.	2014	all ages: the change in the mortality risk for all causes was 0.76 % (95 %CI 0.27-1.26) for socioeconomic status (SES) I (low), 0.58 % (95 %CI 0.16-1.00) for SES II (mid) and -0.29 % (95 %CI -1.16-0.57) for SES III (high) per 10µg/m³ increment in the daily average of PM10 on day of death; For all age groups and people over 65 years old, estimated mortality due to all causes for > 65 years old was similar to that observed for all ages; no significant association was found between cardiovascular causes and PM10 exposure in terms of risk of mortality	0	+
Ostro, B et al.	2006	Age: >65 years; PM and mortality; PM2.5 correspond with increases in all-cause mortality, including respiratory disease and cardiovascular disease	+	
Cournane, Sean et al.	2017	Median age: 68 /PM10, SO2 and NOx daily levels from the hospital catchment area were correlated with the outcomes for the older admission cohort. As admission day pollution increased (NOx quintiles) the 30-day mortality was higher in the elderly >70 (14.2 % vs. 11.3 %: p<0.001)	+	+
Elliott, Paul et al.	2007	Age: 30->65 years; no population details; exposure to black smoke and SO2 and health risks; excess risk found for respiratory mortality; no difference in relative risk found between <65 and >65 years old	0	+
Shi, Liuhua et al.	2016	Age: >65 years; 10938852 subjects; PM2.5 and mortality; significant association between PM2.5 exposure and acute and chronic effects	+	
Zeger, Scott L. et al.	2008	Three age groups: 65-74; 75-84; > 85 years; 10 µg/m3 increase (6 years) of PM2.5 is associated with 6.8 % (95 % CI, 4.9-8.7 % and 13.2 % (95 % CI, 9.5-16.9) increases in mortality; no associations for mortality and PM for older people (> 85)	+	+
Vaneckova, Pavla et al.	2010	Age: > 65 /On unusually hot days, spatial variation in mortality was observed. Elderly people living 5-20 km south-west and west of the Sydney Central Business District were found to be more vulnerable. O3 and PM10 were found to be non significant.	+	+
Zhang, Fengying et al.	2016	Two age groups: 0-65; > 65 /greatest ERs of PM10 and PM2.5 were in 2-day cumulative measures for the all-cause mortality, 2-day lag for females and the young (0-65 years), and L02 for males and the elder (>65 years). PM2.5 had higher risks on all-cause mortality than PM10. Effects of high PM pollution on mortality were stronger in the elder and male	+	+

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Vanos, Jennifer K et al.	2013	Age groups: <64; 65-74; 75-84; > 85 /There was a significant modification of RR by weather type and agr. Ozone seems to have the greatest modifying effect on mortality risk. This effect was highest for dry tropical weather type, with all-age RR of mortality found to be 1.055 (95 %CI, 1.026-1.085). All-weather type risk estimates increased with age due to exposure of CO, NO2 and SO2	+	+
Johnson, H et al.	2005	Three age groups: 0-64; 65-74; > 75 /Mortality for people > 75 increased by 23 % (CI: 21-26 %). All regions had an excess for age groups 75+, greatest in London: 59 %.	+	+
Cakmak, Sabit et al.	2011	Four age groups: < 64; 65-74; 75-84; > 85 /IQR increases in PM10 and PM2.5 were 2-7 % for the age group > 85. Mortality RRs were greater in the oldest compared to the youngest age group for all pollutants.	+	+
Filleul, L.	2003	Age groups: 65-74; 75-84; > 85 /Significant association between daily mortality and black smoke observed. More female mortality on high air pollution days (OR 5.2, 95 % CI 1.32-20.65).	+	+
Vaneckova, Pavla et al.	2010	Age: > 65 /On unusually hot days, spatial variation in mortality was observed. Elderly people living 5-20 km south-west and west of the Sydney Central Business District were found to be more vulnerable. O3 and PM10 were found to be non significant.	+	+

Ozon	**Mortalität**	Diverse	8

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Medina-Ramon, Mercedes et al.	2008	Age: > 65 years; general population; air pollution and hospitalization for cardiovascular disease in elderly; I squared statistic; interquartile range (IQR) increase in pollutant -> PM2.5 - 3.8 microg/m3, PM10 - 7.5 microg/m3, NO2 - 5.1 ppb, CO - 0.9 ppm, ozone - 8.8 ppb; significant association for CO = 2.2 (0.9-3.4), NO2 = 3.0 (2.1-3.9) and PM2.5 = 1.3 (0.6-2.0) total cardiovascular diseases	+	+
Ren, Cizao et al.	2010	Age: > 65 years (83.5 %); 157197 subjects; mortality and ozone modified by socioeconomic status; a 10 ppb increase in four day moving average of maximal 8 h ozone associated with increased risk of respiratory disorders, diabetes, cardiovascular diseases and stroke; no evidence for modification of the association by socioeconomic status	+	+
Stafoggia, Massimo et al.	2010	Age: > 65 years (86.4 %), (35-64 years: 13.6 %); general population 10 Italian cities, 127860 subjects (deaths); association of ozone and mortality considering	+	++

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
		sociodemographic characteristics and chronic conditions; estimated 1.5 % (95 % CI 0.9-2.1) increase in mortality for every 10 microg/m3 in ozone, effect lasted several days for cardiac and respiratory mortality (lag 0-5), delayed for cerebrovascular deaths (lag 3-5); effect stronger in people >85 years than in group of 35-64 years old; effect stronger in women than in men; effect stronger in out-of-hospital deaths, especially with diabetes		
Zanobetti, Antonella; Schwartz, Joel	2008	Age: 0 - > 80 years, no more details; adaptation in the acute mortality risk associated with ambient ozone; 48 cities; 0 day lag effect highest in summer 0.5 % (95 % CI 0.38, 0.62) increase in total mortality for 10 ppb increase in 8 h ozone - decreases to null in autumn and winter; effects higher in June 0.46 % (95 % CI 0.24, 0.68) and July 0.65 % (95 % CI 0.47, 0.82), little evidence of effect up to age 50; a 0.54 % (95 % CI: 0.19, 0.89) increase in total mortality for the age group 51–60. This effect was generally similar up to age 80, lower effect in 80 years and older	+	+
Zhang, Yunhui et al.	2006	ozone and daily mortality; general population; increase in ozone correlates with nonaccidental deaths, cardiovascular and respiratory mortality; estimates increased in colder seasons; effects of ozone not confounded by PM10 or SO2, when adding NO2 effects became insignificant	+	+
Ng, Chris Fook Sheng et al.	2013	65 years and older; general population; association of ozone and mortality; in spring and autumn a 10 ppb increase of daily maximum 8 h average in the previous 3 days associated with all-cause mortality, cardiovascular and respiratory disease; respiratory disease strong in cold season dispite lower ozone levels; results independent of PM and NO2	+	
Almeida, Sofia Pinto de et al.	2011	65 years and older; general population; association between air pollution and mortality; increase of 10 microg/m3 in daily ozone corresponds to 0.95 % (95 % CI 0.30-1.60) in non-accidental mortality and 1.58 % (95 % CI 0.45-2.73) in cardiovascular disease in summer season; 65+ year old every 10 microg/m3 increase -> PM10 - 0.91 % (0.07-1.75) non accidental, 1.13 % (-0.28-2.56) cardiovascular, 2.11 % (-0.40-4.69); NO2 - 0.52 % (-0.21-1.26) non accidental, 0.64 % (-0.59-1.89) cardiovascular, 0.24 % (-2.0-2.53) respiratory; O3 - 0.99 % (0.24-1.75) non accidental, 1.78 % (0.56-2.73) cardiovascular, 1.50 % (-1.42-2.46) respiratory	+	+
Yang, Chunxue et al.	2012	0->65 years of age; general population; association of ozone and mortality; no significant association of O3 among residents aged 0–4, 5–44, or 45–64, elderly over 65 years, the effect estimates were significant for all three metrics of O3 concentration: mortality >65 years old 1-hour maximum increase (%) 2.33 (0.35, 4.31), male (all) 1.69 (-0.71, 4.09), female (all) 1.62 (-0.92, 4.17); 8-hour average 2.80 (0.83,4.77), male 2.21 (-0.18, 4.59), female 1.43 (-1.13, 3.99); 24-hour average 1.93 (0.07, 3.80), male 1.30 (-0.93, 3.53), female 0.53 (-1.90, 2.96)	+	+

Schwermetalle	**Mortalität**	Sonstige	1

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Suwazono, Yasushi et al.	2014	Age: > 50 years, mean age men 64 and women 62; 2317 subjects; cadmium and mortality; urine cadmium significantly associated with increased mortality	+	+

Stickstoffdioxid	**Mortalität**	Diverse	2

AutorInnen	Jahr	Ergebnisse	Effekt	Qualität
Andersen, Zorana Jovanovic et al.	2015	Mean age 56 years; exposure to high levels of traffic-related air pollution did not modify associations, indicating beneficial effects of physical activity on mortality; inverse associations of participation in sports, cycling, and gardening with total, cardiovascular, and diabetes mortality were not modified by NO2	0	+
Naess, Øyvind et al.	2007	Two age groups: 51–70;71–90 years; the elderly seem to be susceptible to air pollution at lower levels than the general population; effects appeared to increase at NO2 levels higher than 40 lg/m3 in the youngest age group and with a linear effect in the interval 20–60 lg/m3 for the oldest. An effect of all indicators on cardiovascular causes, lung cancer, and chronic obstructive pulmonary disease was also found in both age groups and sexes; For the youngest age group, effect estimates were larger. In the oldest age group of women, the effect was comparatively small	-	++
Kan, Haidong et al.	2008	effects of air pollutants were more evident in the cool season than in the warm season, and females (effect estimates of PM10 and O3 among females were approximately twice those among males), and the elderly were more vulnerable to outdoor air pollution. Effects of air pollution were generally greater in residents with low educational attainment; no significant effects of air pollution in residents 5–44 years of age or 45–64 years of age. Among those ≥ 65 years of age, the effect estimates of all four pollutants were significant, and approximately 2–5 times higher than among people 5–44 years of age or 45–64 years of age	+	+
Crouse, Dan L. et al..	2015	various age groups: significant effect modification by age for associations between overall NO2 exposures and non-accidental mortality; stronger associations among subjects aged <60 as compared with those aged 60–79 (i.e., HRs and 95 % CIs: 1.14; 1.11–1.18 and 1.06; 1.04–1.08, respectively) and essentially no association among subjects aged 80–89.	-	++

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