Exceeding particulate matter WHO regulations in Europe and the effect on fetal and early postnatal growth: a systematic review

Julie Bollen & Karen Dilissen, KU Leuven

Promotor: Gijs Van Pottelbergh, Department of Public Health and Primary Care, KU Leuven

Co-promotor: Simon Beerten, Department of Public Health and Primary Care, KU Leuven

Master of Family Medicine
Master's thesis in Family Medicine
Academic year: 2022 – 2023

Deze masterproef is een examendocument dat niet werd gecorrigeerd voor eventueel vastgestelde fouten. Zonder voorafgaande schriftelijke toestemming van zowel de promotor(en) als de auteur(s) is overnemen, kopiëren, gebruiken of realiseren van deze uitgave of gedeelten ervan verboden. Voor aanvragen tot of informatie i.v.m. het overnemen en/of gebruik en/of realisatie van gedeelten uit deze publicatie, wendt u tot de universiteit waaraan de auteur is ingeschreven.

Voorafgaande schriftelijke toestemming van de promotor(en) is eveneens vereist voor het aanwenden van de in dit afstudeerwerk beschreven (originele) methoden, producten, schakelingen en programma's voor industrieel of commercieel nut en voor de inzending van deze publicatie ter deelname aan wetenschappelijke prijzen of wedstrijden.

ABSTRACT

Background: In the last decades, more evidence has been provided concerning the negative health effects of air pollution, and more specifically particulate matter. Children are especially vulnerable as impaired conditions during the developmental phases lead to more extensive consequences.

Objective: To examine whether there is an association between exposure to particulate matter and child development in its earliest stages, i.e. in utero and during the first year of life.

Methods: The search was conducted in eight electronic databases. Studies were eligible if they met PECO criteria, i.e. fetal stages until 1 year of age, exposure to PM of all diameters, comparative and observational studies, and all length, weight and head size measurements as outcome. Studies had to be conducted in Europe and published after January 2017 for inclusion. The JBI critical appraisal tool was used to assess the quality of the included studies.

Results: In total, 16 studies met the eligibility criteria, representing a total study population of 6 827 550 births. The results are not unequivocal, but the most evidence supports a negative effect of PM exposure on growth measurements. For birth weight, being the most studied parameter, a decrease was seen in 9 out of 16 studies. Concerning birth length, the most reported trend was also a decrease (3/6 studies). For head measurements the most consistent results were found, being a decrease shown in 3 out of 4 studies. Lastly, 1 study reported on growth during the first year of life as a small increase in BMI.

Discussion: Higher exposure to particulate matter air pollution during pregnancy negatively affects growth and weight parameters, and fetal and early postnatal development in general. This finding indicates a need for stricter legislation concerning PM air pollution.

SAMENVATTING

Achtergrond: De laatste decennia is er meer bewijs geleverd over de negatieve gezondheidseffecten van luchtverontreiniging, en meer bepaald van fijnstof. Kinderen zijn bijzonder kwetsbaar omdat ongunstige omstandigheden tijdens de ontwikkelingsfase leiden tot meer ingrijpende gevolgen.

Doelstelling: Nagaan of er een verband bestaat tussen blootstelling aan fijnstof en de ontwikkeling van kinderen in de vroegste stadia, d.w.z. in utero en tijdens het eerste levensjaar.

Methoden: Er werd gezocht in 8 elektronische databanken. Studies kwamen in aanmerking als er werd voldaan aan de PECO-criteria, d.w.z. de foetale stadia tot de leeftijd van 1 jaar, blootstelling aan fijnstof van alle diameters, vergelijkende en observationele studies, en alle parameters gerelateerd aan lengte, gewicht en hoofdomvang als uitkomst. De studies moesten in Europa zijn uitgevoerd en na januari 2017 zijn gepubliceerd voor inclusie. De JBI critical appraisal tool werd gebruikt om de kwaliteit van de geïncludeerde studies te beoordelen.

Resultaten: In totaal voldeden 16 studies aan de inclusiecriteria, met een totale studiepopulatie van 6 827 550 geboorten. De resultaten zijn niet eenduidig, maar het meeste bewijs ondersteunt een negatief effect van fijnstofblootstelling op groei. Voor het geboortegewicht, de meest bestudeerde parameter, werd een daling gezien in 9 van de 16 studies. Voor geboortelengte was het meest gerapporteerde resultaat ook een afname (3/6 studies). Voor hoofdomtrek werden de meest consistente resultaten gevonden, namelijk een afname in 3 van de 4 studies. Ten slotte rapporteerde 1 studie een kleine toename van het BMI tijdens het eerste levensjaar.

Discussie: Hogere blootstelling aan luchtverontreiniging door fijnstof tijdens de zwangerschap heeft een negatief effect op groei- en gewichtsparameters, en op de foetale en vroege postnatale ontwikkeling in het algemeen. Deze bevinding wijst op de nood aan strengere wetgeving inzake fijnstof-luchtverontreiniging.

1. INTRODUCTION

In recent decades, more attention has been paid to the impact of air pollution as an environmental influence on health. The five major contributors to air pollution are ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide and particulate matter (1). The latter component is the subject of interest in this systematic review.

Particulate matter is an umbrella term for small particles of different origin, composition and size (2–6). It is defined as particles with a diameter smaller than 10 micrometers (PM_{10}, for Particulate Matter). A subcategory is $PM_{2.5}$, which correspondingly stands for particles with a diameter smaller than 2.5 micrometers. Particles with a diameter of less than 100 nanometers (0.1µm) are referred to as ultrafine particles (UFPs) or nanoparticles (NPs). Particulate matter arises from natural processes, such as wind friction, dispersion of dusty sand from the desert, and from evaporation of seawater (2–5). However, most of the particulate matter measured today comes from human activity (2–5). Industry and transportation (cars, trucks, aviation) represent the largest share (2,4,6) but also domestic heating and livestock farming have a high share.

Multiple studies have concluded that exposure to PM air pollution has adverse health effects in adults, both in terms of morbidity and mortality (2–4,7–17). These negative effects were mainly observed in respiratory and cardiovascular morbidity.

Due to the evidence of adverse health effects of particulate matter, the World Health Organization (WHO) formulates recommendations regarding air pollution. The latest WHO recommendation, revised in 2021, sets the limit for annual average concentration at 15µg/m^3 for PM_{10} and 5µg/m^3 for $PM_{2.5}$ (18,19). However, the current European Union (EU) regulation, dating from 2008, is more permissive and sets the limit for PM_{10} and $PM_{2.5}$ at 40µg/m^3 and 25µg/m^3 respectively (20,21) (Figure 1).

	WHO	**EU**
PM_{10}	15 µg/m^3	40 µg/m^3
$PM_{2.5}$	5 µg/m^3	25 µg/m^3

Fig. 1 Mean annual exposure limits (18–21)

Air quality data, made available by the EU, show that in 2021, the EU limit for PM_{10} was respected in 99.66% and for $PM_{2.5}$ in 93.63% of monitoring stations across Europe. However, using the thresholds set by the WHO, the limits were not exceeded for PM_{10} in 26.56% and for $PM_{2.5}$ in only 3.24% of the monitoring stations (22).

One population that appears to be particularly susceptible to the negative effects of exposure to air pollution, is children. Negative impact was observed in terms of lung development, lung function and brain development in children (16,23–27).

This systematic review examines whether there is an association between exposure to particulate matter and child development in its earliest stages, i.e. in utero and during the first year of life.

2. METHODS

2.1 Study objective

We developed the following PECO statement (28,29):

Population: The study population of interest includes unborn children (starting from the fetal stage until birth) and young children until the age of 1 year.

Exposure: Particulate matter including all diameters and all different production sources (natural and industrial).

Comparison: Comparative studies with comparison of all different levels of PM exposure and non-comparative studies e.g. observational studies.

Outcome: Our primary interest was growth parameters. These could be categorized into three major categories, namely weight, length, and head size measurements. Other relevant measurements related to growth (e.g. intrauterine growth restriction, small for gestational age and abdominal diameter) were also taken into account.

2.2 Literature search

We conducted a systematic search on May 5, 2022 including all articles published in the following 8 databases (from inception): PubMed, Embase, Web of Science (core collection), Cochrane Library, CINAHL (via EBSCO), Web of Science: BIOSIS, Scopus and GreenFILE (via EBSCO). The search included terms to capture the following three concepts: fetus or infant, particulate matter and growth and development (see Appendix 1 for the full search strategy).

2.3 Study selection

After implementing the systematic search and removing all duplicates, the two authors (Dilissen K. and Bollen J.) screened the 5944 articles manually and separately. Articles were excluded if they did not meet the PECO statement or if particulate matter exposure was exclusively sourced from cigarette smoke. In a second phase, only studies published from January 2017 to May 2022 and conducted in Europe were eligible for inclusion to obtain the most up-to-date results. Ultimately, 11 articles were in conflict and were reviewed by both authors for consensus. A total of 16 articles qualified for inclusion (See table of finding in Appendix 2). The full PRISMA flow diagram is presented in Figure 2. We used the JBI critical appraisal tool to assess the quality and potential bias of those studies (30) (Appendix 3).

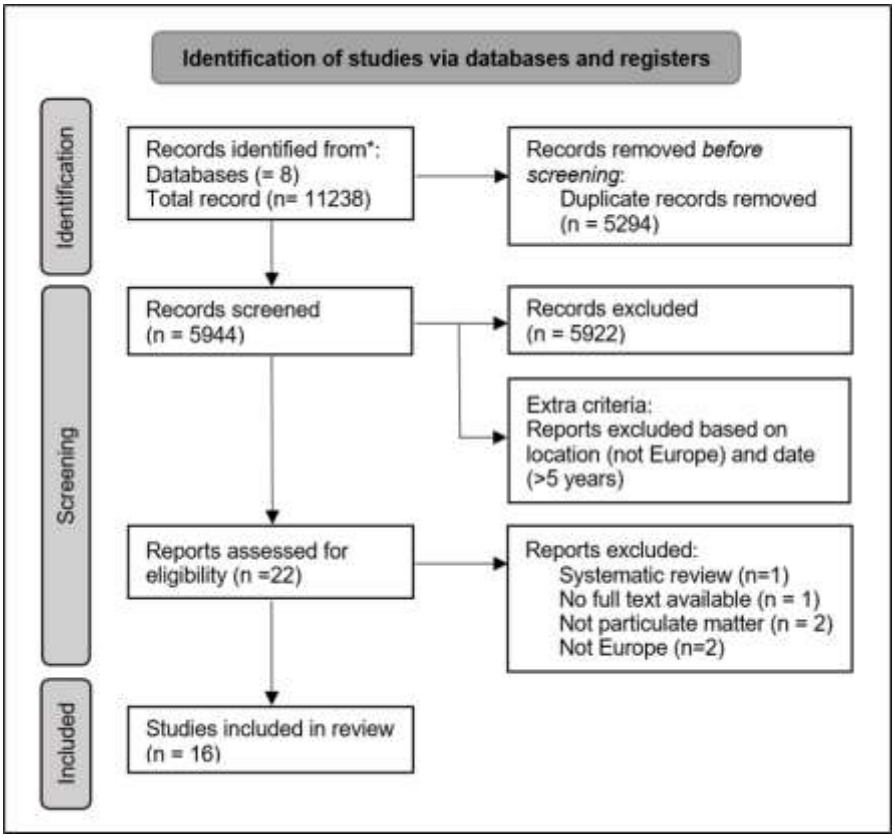

Fig. 2 Flow diagram of literature search

3. RESULTS

3.1 Effect of PM exposure on head circumference and associated measurements

Four studies reported on these measurements. Three of them observed a small decrease in head circumference (HC). *Jedrychowski et al.* noted a decrease of 0.3cm [no CI mentioned] per increase of 1 ln (natural logarithmic) unit in $PM_{2.5}$ concentration exposure during the second trimester (31). *Bergstra et al.* observed a smaller effect of -0.09cm [95%CI -0.14, -0.04] per increase of 1 interquartile range (IQR; 0.41µg/m3) PM_{10} (32). *Clemens et al.* reported that in growth trajectories from late second trimester onward biparietal diameter (BPD) was observed to be 2.18mm and 2.28mm [no CI] smaller at 36 weeks compared to the lowest exposure for $PM_{2.5}$ and PM_{10}, respectively. At birth, occipitofrontal circumference (OFC) was also decreased, being 0.14cm smaller in relation to $PM_{2.5}$ [95%CI -0.25, -0.02] and 0.16cm smaller in relation to PM_{10} [95%CI -0.29, -0.02] (33).

One study, on the other hand, saw a very limited but significant increase in HC with exposure during the first trimester (+0.10cm [95% CI 0.04, 0.15]) (34).

3.2 Effect of PM exposure on birth length and associated measurements

Six studies reported on length parameters. Two of them saw no correlation between PM exposure and birth length (BL) (35,36). *Chen et al.* saw a small increase in BL (+0.10cm [95%CI 0.03, 0.18]), with the greatest effect during the first trimester (+0.15cm [95%CI 0.06, 0.23]) (34). Two studies observed a decline in BL of 0.54cm (second trimester) (no CI) and 0.12cm, per increase of 1 ln unit in $PM_{2.5}$ concentration and per IQR of 0.41µg/m3 PM_{10} respectively (31,32). *Clemens et al.* did not find an association with antenatal measurement of fetal length (FL) and abdominal circumference (AC), but

at birth they did find a decline in crown heel length (CHL) of respectively 0.23cm [95%CI -0.40, -0.05] and 0.22cm [95%CI -0.42, -0.01] with $PM_{2.5}$ and PM_{10} exposure (33).

3.3 Effect of PM exposure on birth weight and associated measurements

All studies except one investigated the effect of PM exposure on weight measurements.
In this category, the most frequently reported parameter is birth weight (BW), with mention in ten studies. Following, the results are discussed in more detail according to effects reported over the entire pregnancy versus trimester-specific.

A general decline at the end of pregnancy was observed in three studies, with a decrease of 15.85g [95%CI -28.26, -3.45] per interquartile range of 0.41µg/m3 PM_{10} reported by a Dutch study (32). In areas in Poland with a concentration of $PM_{2.5}$ > 25µg/m3, a significant decrease was observed, i.e. -115g [no CI] (36). Thirdly, *Palma et al.* reported a decrease in BW of 0.5% or -18.42g per 10 additional units (i.e. about 1 SD (standard deviation)) of the mean PM_{10} level (35).

In five studies weight changes were attributed per trimester.
During the first trimester of pregnancy *Giovannini et al.* observed a decrease in BW of 22.2g [95%CI -35.7, -8.7] per 10µg/m3 PM_{10} exposure. Effects for the second and third trimesters in this study were not significant (37). *Ouidir et al.* on the other hand, described a significant but non-quantified increase in term birth weight (TBW) for both $PM_{2.5}$ and PM_{10} exposure (38).
In the second trimester, three studies observed a decrease in birth weight. One showed a decline of 78.83g [no CI] per unit $PM_{2.5}$ (31), another a decrease of 66.34g [95%CI -126.61, -6.08] during the fourth month (39) and the last one a drop of 12.3g [95%CI -22.4, -2.2] per 5µg/m3 $PM_{2.5}$ exposure (38). In the latter study no significant effect could be demonstrated for PM_{10}.
For the third trimester, this study also noted a reduction of 27.0g [95%CI -36.6, -17.4] per 5µg/m3 $PM_{2.5}$ and a similar decrease of 26.9g [95%CI -36.6, -17.6] for PM_{10} (38). *Liu et al.* reported an increase of 102.75g [95%CI 70.65, 134.85] per 5 µg/m^3 $PM_{2.5}$ exposure during the third trimester (39). *Palma et al.* saw in addition to a decrease over the entire pregnancy, that the strongest effect on BW was measured in the third trimester (-28.409g [no CI]) (35).

No significant correlation between PM and BW could be demonstrated in three studies (33,34,40).

Results for low birth weight (LBW) and small for gestational age (SGA), defined as birth weight below the tenth percentile, were reported in ten studies.
First, a time series study observed a period of nine years in Spain, and concluded that with an increase of 10µg PM_{10}/m^3 there was a relative risk (RR) for LBW of 1.104 [95%CI 1.072, 1.138]. The strongest effects were seen in the first and third trimester (41). A study in the Bristol area reported a higher risk of term low birth weight (TLBW) and SGA in the third trimester associated with PM_{10}, with an odds ratio (OR) of 1.40 [95%CI 1.12, 1.75] and 1.18 [95%CI 1.05, 1.32] per IQR (6,54 µg/m^3) respectively (34). *Wojtyla et al.* saw a significantly increased OR of 4.3 [95%CI 1.5, 12.3] when exposed to $PM_{2.5}$ >25µg/m3 compared to exposure below this cut-off (36). *Palma et al.* reported a 22% increase in prevalence of LBW with an exposure per 10 additional units (i.e. about 1 SD) of the mean PM_{10} level. These effects were yet again the strongest in the third trimester (35). In London, exposure of $PM_{2.5}$ >13.8µg/m^3 could be linked to an estimated 3% of all term LBW cases, with LBW OR 1.06 [95%CI 1.01,1.12] for $PM_{2.5}$. However with SGA no significant correlation was found (42). One study

investigated the effect of nanoscale particles (NPs). Here, they also found a higher risk for SGA when occupationally exposed to NPs, adjusted odds ratio (aOR) 1.63 [95%CI 1.22, 2.18] (43).

Four studies could not demonstrate a significant effect of PM on LBW or SGA (32,40,44,45).

3.4 Effect of PM exposure on the first year of life

Only one study focused on the effect of air pollution in early postnatal life. *De Bont et al.* observed a small increase in body mass index (BMI) of 0.096 [95%CI 0.020, 0.172] per 6,3µg PM_{10}/m^3 increase during the first two months of life. There was no significant association observed during the first six months for $PM_{2.5}$ (46).

4. DISCUSSION

There was an exponential growth over the last few decades in the number of articles reporting on the impact of particulate matter and other environmental influences on the health of the unborn child (Figure 3). This endorses the relevance of this research.

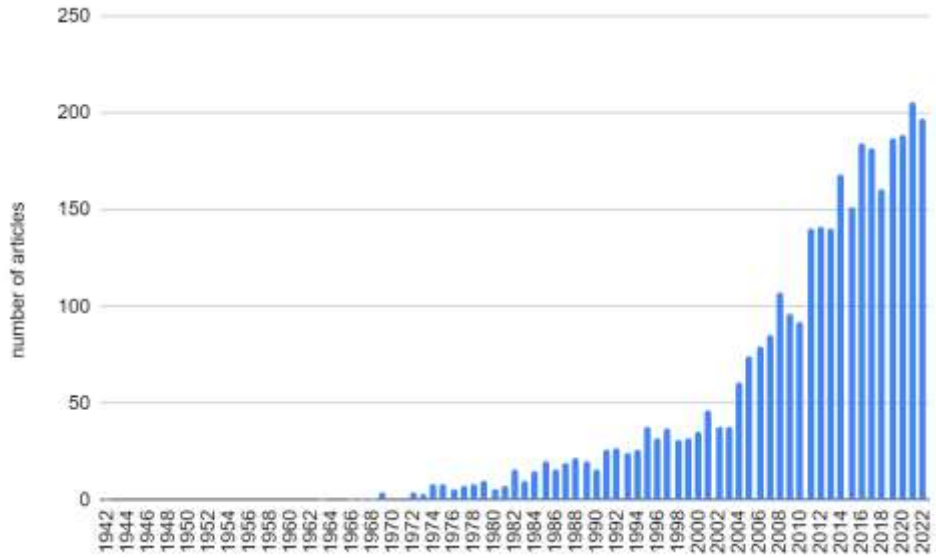

Fig. 3 Number of articles matching our search strategy (Appendix 1) in PubMed database by year of publication (1942-2022)

The observation that the limit values set by the WHO are widely exceeded in Europe (see Introduction), is reflected by the studies in this review. Only 2 studies (33,40) described an annual mean for PM_{10} below the upper limit set by WHO. For $PM_{2.5}$, no studied exposures met the criteria.

The results in this study are not completely unequivocal. Overall, however, a trend can be observed. Higher exposure to particulate matter negatively affects fetal growth.

The most studied parameter of fetal growth is BW, with five out of ten studies reporting a significant negative effect (31,32,35–37). Another three showed no correlation (33,34,40), and two reported inconclusive results (38,39). Concerning LBW, five out of eight studies reported an increased risk (34–36,41,42), and three found no significant effect (32,44,45). For SGA the association is less clear as only

two out of six studies reported an increased risk (34,43), versus four that could not demonstrate a correlation (32,40,42,44).
Concerning BL, three out of six studies showed a negative effect of PM exposure (31–33). Two studies found no correlation (35,36), and one saw an overall increase in BL (34).
For HC, the most consistent results were found as three out of four studies reporting on this parameter showed a negative effect (31–33). One study could not prove a correlation (34).
These observations are in line with previous research on negative health effects of PM exposure.

Trimester-specific results are described in eight studies.
For BW and associated measurements, the greatest decrease seems to be observed in the third trimester, as two studies reported so (34,35). However, one study described the largest decrease in the first trimester (37), one in the first and third trimester (41). Another study reported a significant decrease during the second trimester, although this result cannot be compared to the other two trimesters, as they were not included in this study (31). Lastly, two studies reported an inconclusive result (38,39).
For HC three studies reported trimester-specific results. One showed the most significant decrease in the third trimester (33). One reported a significant decrease during the second trimester, as discussed above not comparable to the other trimesters (31). The last one reported the main effect during the first trimester, being a small increase in HC (34).
Concerning BL, two studies reported trimester-specific values. One observed the main effect in the first trimester as a small increase (34). However, *Jedrychowski et al.* reported a decline during the second trimester, again without information about the first and third trimester (31).
To conclude, the greatest effects seem to be in the first and third trimester of pregnancy but at present there is insufficient evidence to draw unequivocal conclusions regarding trimester-specific effects.

The results published from the five studies that looked at both PM_{10} and $PM_{2.5}$, are diverse. *Clemens et al.* and *Ouidir et al.* proved significant results for the two types of pollutants, but with an overall stronger and more consistent association for $PM_{2.5}$ (33,38). One study only showed a significant result for $PM_{2.5}$ (42), another one only for PM_{10} (46). In the study of *Balogun et al.* neither of the pollutants had an association (45).
From these results can be concluded that the particles with the smallest diameter ($PM_{2.5}$) contribute the most to the negative effects of PM air pollution on growth. More comparative studies are needed to substantiate this statement.

Although the biological mechanisms by which PM air pollution affects fetal health are not yet completely understood, several mechanisms have been posited. It is known that inhaled PM can cross into the maternal bloodstream, pass through the placenta and end up in the fetal circulation (47). In this manner, PM causes oxidative stress (48,49), systemic inflammation (50,51), endocrine disruption and alterations to maternal-placental blood flow (52–55). Those adverse effects result in placental hypoperfusion and consequently a reduction of fetal oxygen and nutrition transfer (56,57). Furthermore, those mechanisms can also cause alterations and breakage of the DNA chain (58). The combination of these adverse mechanisms during pregnancy result in impaired fetal growth. Our finding that the greatest negative effects are seen in the first and 3rd trimester, can be explained by the formation of vital organs during embryogenesis in the first trimester and the greatest weight gain in the third trimester (35,36) .

Strengths and limitations
There are several strengths of this current research.
The two authors performed an independent quality assessment of the included studies separately. In case of disagreement, consensus was obtained through discussion. The overall quality of the studies was good. For a more detailed review, see Appendix 3.

Multiple growth measurements were included, all parameters related to length, weight and head circumference, both prenatal and at birth were eligible. By combining these parameters, fetal and early postnatal growth could be analysed as a whole, which could give a reinforcing effect on the overall trends.
Additionally, all different diameters of particulate matter were included. The most common being $PM_{2.5}$ and PM_{10}, and one article reported on NPs. This is important because these pollutants are commonly occurring together and by making a selection, relevant outcomes could have been missed.
Study populations were relatively large. Four studies had sample sizes between 1,000 and 10,000 subjects, and in 9 studies n was > 10,000. This is an advantage because quantitatively small effects can yet be demonstrated.

There are some limitations to the evidence found in this systematic review.
First of all, few studies reported on follow up rate. Given that many of the included studies used a longitudinal design, it seems plausible that some degree of loss to follow up was present. In the absence of data on loss to follow up, selection bias cannot be excluded.
Secondly, gestational age is a factor not to be overlooked in determining whether or not fetal growth is adequate. The majority of studies corrected for this confounder when reporting growth parameters. However, three studies did not correct for gestational age in their statistical models (35,41,45). Consequently, these results may not be reliable. Another important factor that affects fetal growth in a negative way is maternal smoking. This was taken into account in most studies. However in five studies, maternal smoking was not corrected for and thus an important effect modifier was not taken into account when interpreting the data (35,37,40–42).
Also, there is no gold standard to determine individual exposure to PM. The most commonly used method is the use of atmospheric dispersion models to estimate average daily to monthly concentrations of ambient PM. Based on particles registered in monitoring stations and by geocoding maternal residential addresses, individual-level prenatal exposure was computed. Several models were used by different authors. The quality assessment of these varying methods was not part of the scope of this study. Yet, it is relevant to mention, three studies relied on annual average concentrations (32,33,46). This is less accurate as it reduces individual variability, and may consequently lead to misclassification. Furthermore, another inferior method was the linking of mothers through their occupation with unintentional NPs exposure (43).
In general, little consideration was given to moving participants or individual temporary mobility. A Polish study assigned women to the place of delivery, not considering if the women resided in the vicinity of the hospital, possibly contributing to misclassification (36).
A different design was presented in the *Jedrychowski* study. All women received a personal monitor for three consecutive days (31). Although not most frequently used, this method is highly accurate. In a perfect study this would be done for a longer period of time, to measure the exposure even more exact.
One of the included studies was limited to elective cesarean sections (37). The results found in this study may not be representative of the entire population.
Finally, potential misclassification bias may have arisen because *Ghosh et al.* classified all included births dating before 2006 as 'term' due to lack of data (40).

5. CONCLUSION

Air pollution is a global challenge that should be considered not only at an individual but primarily on population level. Our systematic literature review is of importance because it provides evidence that PM air pollution during pregnancy negatively affects fetal and early postnatal development. This in turn may lead to long-term comorbidity and mortality. Additional cohort studies, preferably measuring personal PM exposure at multiple times throughout pregnancy, may provide valuable information to further substantiate this statement.

This evidence, combined with the observation that the WHO standards are currently widely exceeded across Europe, indicates a significant need for stricter legislation around PM standards to protect health at population level.

References

1. AQI Basics | AirNow.gov [Internet]. [cited 2023 Apr 13]. Available from: https://www.airnow.gov/aqi/aqi-basics/

2. Fuchsig H. Particulate matter in offices. Atemwegs- und Lungenkrankheiten. 2008;34(10):396–9.

3. Wat is fijn stof? — Vlaamse Milieumaatschappij [Internet]. [cited 2023 Apr 13]. Available from: https://www.vmm.be/lucht/fijn-stof/wat-is-fijn-stof

4. Fijn stof | sciensano.be [Internet]. [cited 2023 Apr 13]. Available from: https://www.sciensano.be/nl/gezondheidsonderwerpen/fijn-stof#wat-zijn-de-gezondheidsrisico-s-van-fijn-stof-

5. Particulate Matter (PM) Basics | US EPA [Internet]. [cited 2023 Apr 13]. Available from: https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

6. Luchtkwaliteit - Naar een gezond België [Internet]. [cited 2023 Apr 13]. Available from: https://www.gezondbelgie.be/nl/gezondheidstoestand/determinanten-van-gezondheid/luchtkwaliteit#fijn-stof

7. Beelen R, Raaschou-Nielsen O, Stafoggia M, Andersen ZJ, Weinmayr G, Hoffmann B, et al. Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project. Lancet [Internet]. 2014 Mar 1;383(9919):785–95. Available from: https://doi.org/10.1016/S0140-6736(13)62158-3

8. Peters A, Dockery DW, Muller JE, Mittleman MA. Increased particulate air pollution and the triggering of myocardial infarction. Circulation. 2001;103(23):2810–5.

9. Pope CA, Ezzati M, Dockery DW. Fine-Particulate Air Pollution and Life Expectancy in the United States. N Engl J Med. 2009;360(4):376–86.

10. Hong YC, Lee JT, Kim H, Ha EH, Schwartz J, Christiani DC. Effects of air pollutants on acute stroke mortality. Environ Health Perspect. 2002;110(2):187–91.

11. McConnell R, Berhane K, Gilliland F, London SJ, Islam T, Gauderman WJ, et al. Asthma in exercising children exposed to ozone: a cohort study. Lancet [Internet]. 2002 Feb 2;359(9304):386–91. Available from: https://doi.org/10.1016/S0140-6736(02)07597-9

12. Liu H, Tian Y, Xiang X, Sun K, Juan J, Song J, et al. Air Pollution and Hospitalization for Acute Myocardial Infarction in China. Am J Cardiol [Internet]. 2017 Sep 1;120(5):753–8. Available from: https://doi.org/10.1016/j.amjcard.2017.06.004

13. Dockery DW, Luttman-Gibson H, Rich DQ, Link MS, Mittleman MA, Gold DR, et al. Association of air pollution with increased incidence of ventricular tachyarrhythmias recorded by implanted cardioverter defibrillators. Environ Health Perspect. 2005;113(6):670–4.

14. Di Q, Wang Y, Zanobetti A, Wang Y, Koutrakis P, Choirat C, et al. Air Pollution and Mortality in the Medicare Population. N Engl J Med. 2017;376(26):2513–22.

15. Mustafic H, Jabre P, Caussin C, Murad MH, Escolano S, Tafflet M, et al. CLINICIAN ' S CORNER Main Air Pollutants and Myocardial Infarction. 2016;307(7):713–21.

16. Overview of occupational and environmental health - UpToDate [Internet]. [cited 2023 Apr 13]. Available from: https://www-uptodate-com.kuleuven.e-bronnen.be/contents/overview-of-occupational-and-environmental-health?search=https:%2F%2Fwww-uptodate-com.kuleuven.ezproxy.kuleuven.be%2Fcontents%2Foverview-of-occupational-and-

environmental-health%3Fsearch%3Dparticulate matter%26source%3Dsearch_result%26selectedTitle%3D1~150%26usage_type%3Ddefault%26display_rank%3D1%23H543488597&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1

17. Health and Environmental Effects of Particulate Matter (PM) | US EPA [Internet]. [cited 2023 Apr 13]. Available from: https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm

18. What are the WHO Air quality guidelines? [Internet]. [cited 2023 Apr 15]. Available from: https://www.who.int/news-room/feature-stories/detail/what-are-the-who-air-quality-guidelines

19. Organization WH. WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide [Internet]. Geneva PP - Geneva: World Health Organization; Available from: https://apps.who.int/iris/handle/10665/345329

20. I DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2008 on ambient air quality and cleaner air for Europe.

21. EU air quality standards [Internet]. [cited 2023 Apr 15]. Available from: https://environment.ec.europa.eu/topics/air/air-quality/eu-air-quality-standards_en

22. Statistical viewer [Internet]. [cited 2023 Apr 15]. Available from: https://eeadmz1-cws-wp-air02.azurewebsites.net/index.php/users-corner/statistical-viewer/

23. Rees N. DANGER in the air. Aerosp Am. 2018;56(3):30–4.

24. Gehring U, Wijga AH, Hoek G, Bellander T, Berdel D, Brüske I, et al. Exposure to air pollution and development of asthma and rhinoconjunctivitis throughout childhood and adolescence: a population-based birth cohort study. Lancet Respir Med [Internet]. 2015 Dec 1;3(12):933–42. Available from: https://doi.org/10.1016/S2213-2600(15)00426-9

25. Children: new threats to health [Internet]. [cited 2023 Apr 15]. Available from: https://www.who.int/news-room/fact-sheets/detail/children-new-threats-to-health

26. Children and Air Pollution | American Lung Association [Internet]. [cited 2023 Apr 13]. Available from: https://www.lung.org/clean-air/outdoors/who-is-at-risk/children-and-air-pollution

27. Gauderman WJ, Avol E, Gilliland F, Vora H, Thomas D, Berhane K, et al. The effect of air pollution on lung development from 10 to 18 years of age. N Engl J Med. 2004 Sep;351(11):1057–67.

28. Jensen K. 7 Steps To the Perfect Pico Search. EBSCO Heal. 2017;2–7.

29. How to clarify a clinical question | BMJ Best Practice [Internet]. [cited 2023 Apr 15]. Available from: https://bestpractice.bmj.com/info/toolkit/learn-ebm/how-to-clarify-a-clinical-question/

30. Critical Appraisal Tools | JBI [Internet]. [cited 2023 Apr 15]. Available from: https://jbi.global/critical-appraisal-tools

31. Jedrychowski WA, Majewska R, Spengler JD, Camann D, Roen EL, Perera FP. Prenatal exposure to fine particles and polycyclic aromatic hydrocarbons and birth outcomes: a two-pollutant approach. Int Arch Occup Environ Health [Internet]. 2017;90(3):255–64. Available from: "http://dx.doi.org/10.1007/s00420-016-1192-9

32. Bergstra AD, Brunekreef B, Burdorf A. The influence of industry-related air pollution on birth outcomes in an industrialized area. Environ Pollut [Internet]. 2021;269(2):115741. Available from: https://doi.org/10.1016/j.envpol.2020.115741

33. Clemens T, Turner S, Dibben C. Maternal exposure to ambient air pollution and fetal growth in North-East Scotland: A population-based study using routine ultrasound scans. Environ Int [Internet]. 2017;107(February):216–26. Available from: http://dx.doi.org/10.1016/j.envint.2017.07.018

34. Chen Y, Hodgson S, Gulliver J, Granell R, Henderson AJ, Cai Y, et al. Trimester effects of source-specific PM 10 on birth weight outcomes in the Avon Longitudinal Study of Parents and Children (ALSPAC). 2021;1–12.

35. Palma A, Petrunyk I, Vuri D. Prenatal air pollution exposure and neonatal health. Heal Econ (United Kingdom). 2022;31(5):729–59.

36. Wojtyla C, Zielinska K, Wojtyla-Buciora P, Panek G. Prenatal fine particulate matter (Pm2.5) exposure and pregnancy outcomes—analysis of term pregnancies in poland. Int J Environ Res Public Health. 2020;17(16):1–9.

37. Giovannini N, Schwartz L, Cipriani S, Parazzini F, Baini I, Signorelli V, et al. Particulate matter (PM10) exposure, birth and fetal-placental weight and umbilical arterial pH: results from a prospective study. J Matern Neonatal Med [Internet]. 2018;31(5):651–5. Available from: https://doi.org/10.1080/14767058.2017.1293032

38. Ouidir M, Seyve E, Rivière E, Bernard J, Cheminat M, Cortinovis J, et al. Maternal ambient exposure to atmospheric pollutants during pregnancy and offspring term birth weight in the nationwide ELFE cohort. Int J Environ Res Public Health. 2021;18(11):1–17.

39. Liu Z, Szpiro AA, Workalemahu T, Young MT, Kaufman JD, Enquobahrie DA. Associations of perinatal exposure to PM 2 . 5 with gestational weight gain and offspring birth weight. Environ Res [Internet]. 2022;204(PB):112087. Available from: https://doi.org/10.1016/j.envres.2021.112087

40. Ghosh RE, Freni-Sterrantino A, Douglas P, Parkes B, Fecht D, de Hoogh K, et al. Fetal growth, stillbirth, infant mortality and other birth outcomes near UK municipal waste incinerators; retrospective population based cohort and case-control study. Environ Int [Internet]. 2019;122(October 2018):151–8. Available from: https://doi.org/10.1016/j.envint.2018.10.060

41. Arroyo V, Díaz J, Salvador P, Linares C. Impact of air pollution on low birth weight in Spain: An approach to a National Level Study. Environ Res [Internet]. 2019;171(October 2018):69–79. Available from: https://doi.org/10.1016/j.envres.2019.01.030

42. Smith RB, Fecht D, Gulliver J, Beevers SD, Dajnak D, Blangiardo M, et al. Impact of London's road traffic air and noise pollution on birth weight: Retrospective population based cohort study. BMJ. 2017;359:1–13.

43. Manangama G, Migault L, Audignon-Durand S, Gramond C, Zaros C, Bouvier G, et al. Maternal occupational exposures to nanoscale particles and small for gestational age outcome in the French Longitudinal Study of Children. Environ Int [Internet]. 2019;122(October 2018):322–9. Available from: https://doi.org/10.1016/j.envint.2018.11.027

44. Ottone M, Broccoli S, Parmagnani F, Giannini S, Scotto F, Bonvicini L, et al. Source-related components of fi ne particulate matter and risk of adverse birth outcomes in Northern Italy. Environ Res [Internet]. 2020;186(December 2019):109564. Available from:

https://doi.org/10.1016/j.envres.2020.109564

45. Balogun HA, Rantala AK, Antikainen H, Siddika N, Amegah AK, Ryti NRI, et al. Effects of air pollution on the risk of low birth weight in a cold climate. Appl Sci. 2020;10(18):1–18.

46. de Bont J, Hughes R, Tilling K, Díaz Y, de Castro M, Cirach M, et al. Early life exposure to air pollution, green spaces and built environment, and body mass index growth trajectories during the first 5 years of life: A large longitudinal study. Environ Pollut [Internet]. 2020;266:115266. Available from: https://doi.org/10.1016/j.envpol.2020.115266

47. Perera FP, Jedrychowski W, Rauh V, Whyatt RM. Molecular epidemiologic research on the effects of environmental pollutants on the fetus. Environ Health Perspect. 1999 Jun;107 Suppl 3(Suppl 3):451–60.

48. Burton GJ, Jauniaux E. Oxidative stress. Best Pract Res Clin Obstet Gynaecol. 2011 Jun;25(3):287–99.

49. Jauniaux E, Burton GJ. [The role of oxidative stress in placental-related diseases of pregnancy]. J Gynecol Obstet Biol Reprod (Paris). 2016 Oct;45(8):775–85.

50. Møller P, Danielsen PH, Karottki DG, Jantzen K, Roursgaard M, Klingberg H, et al. Oxidative stress and inflammation generated DNA damage by exposure to air pollution particles. Mutat Res Rev Mutat Res. 2014;762:133–66.

51. Hertel S, Viehmann A, Moebus S, Mann K, Bröcker-Preuss M, Möhlenkamp S, et al. Influence of short-term exposure to ultrafine and fine particles on systemic inflammation. Eur J Epidemiol. 2010 Aug;25(8):581–92.

52. Panasevich S, Leander K, Rosenlund M, Ljungman P, Bellander T, de Faire U, et al. Associations of long- and short-term air pollution exposure with markers of inflammation and coagulation in a population sample. Occup Environ Med. 2009 Nov;66(11):747–53.

53. Baccarelli A, Zanobetti A, Martinelli I, Grillo P, Hou L, Giacomini S, et al. Effects of exposure to air pollution on blood coagulation. J Thromb Haemost. 2007 Feb;5(2):252–60.

54. Nääv Å, Erlandsson L, Isaxon C, Åsander Frostner E, Ehinger J, Sporre MK, et al. Urban PM2.5 Induces Cellular Toxicity, Hormone Dysregulation, Oxidative Damage, Inflammation, and Mitochondrial Interference in the HRT8 Trophoblast Cell Line. Front Endocrinol (Lausanne). 2020;11:75.

55. Clemente DBP, Casas M, Vilahur N, Begiristain H, Bustamante M, Carsin A-E, et al. Prenatal Ambient Air Pollution, Placental Mitochondrial DNA Content, and Birth Weight in the INMA (Spain) and ENVIRONAGE (Belgium) Birth Cohorts. Environ Health Perspect. 2016 May;124(5):659–65.

56. Slama R, Darrow L, Parker J, Woodruff TJ, Strickland M, Nieuwenhuijsen M, et al. Meeting report: atmospheric pollution and human reproduction. Environ Health Perspect. 2008 Jun;116(6):791–8.

57. Erickson AC, Arbour L. The shared pathoetiological effects of particulate air pollution and the social environment on fetal-placental development. J Environ Public Health. 2014;2014:901017.

58. Topinka J, Binková B, Mracková G, Stávková Z, Peterka V, Benes I, et al. Influence of GSTM1 and NAT2 genotypes on placental DNA adducts in an environmentally exposed population. Environ Mol Mutagen. 1997;30(2):184–95.

Appendix 1 - Full search strategy

PUBMED

("**Infant"[Mesh]** OR "Infant*"[tiab] OR "Newborn*"[tiab] OR "Neonate*"[tiab] OR "Neonatal"[tiab] OR "baby"[tiab] OR "babies"[tiab] OR "Recently born"[tiab] OR "**Fetus"[Mesh]** OR "Fetus*"[tiab] OR "Foetus*"[tiab] OR "Feti"[tiab] OR "Foeti"[tiab] OR "Fetal"[tiab] OR "Foetal"[tiab] OR "**Gestational Age"[Mesh]** OR "Gestational Age"[tiab])

AND

(("**Particulate Matter"[Mesh]** OR "PM10"[tiab] OR "PM(10)"[tiab] OR "PM2.5"[tiab] OR "PM(2.5)"[tiab] OR "ultrafine fiber*"[tiab] OR "ultrafine particle*"[tiab] OR "Particulate*"[tiab] OR "ash"[tiab] OR "ashes"[tiab] OR "dust*"[tiab] OR "smog"[tiab] OR "smoke"[tiab] OR "soot"[tiab] OR "black carbon*"[tiab] OR **"Air Pollutants"[Mesh:NoExp]** OR "**Air Pollutants, Occupational"[Mesh] OR** "**Greenhouse Gases"[Mesh]** OR "pollutant*"[tiab] OR "greenhouse gas*"[tiab] OR "**Air Pollution"[Mesh:NoExp]** OR **"Air Pollution, Indoor"[Mesh]** OR "air pollution"[tiab] OR "air quality"[tiab] OR "**Vehicle Emissions"[Mesh]** OR "vehicle emission*"[tiab] OR "vehicular emission*"[tiab] OR "car emission*"[tiab] OR "automobile emission*"[tiab] OR "transport emission*"[tiab] OR "transportation emission*"[tiab] OR "traffic emission*"[tiab] OR "exhaust"[tiab] OR "**Traffic-Related Pollution"[Mesh]** OR "Traffic-Related Pollution"[tiab] OR "Traffic Related Pollution"[tiab] OR "traffic pollution"[tiab] OR "particle pollution"[tiab] OR "transport pollution"[tiab] OR "transportation pollution"[tiab] OR "pollution transport"[tiab] OR "pollution transportation"[tiab] OR "flue gas*"[tiab] OR "atmospheric aerosol*"[tiab] OR "air monitoring"[tiab]))

AND

("Fetal Development"[Mesh:NoExp] OR "fetal development"[tiab] OR "fetus development"[tiab] OR "fetal growth"[tiab] OR "fetus growth"[tiab] OR **"Body Height"[Mesh] OR** "body height*"[tiab] OR "body length*"[tiab] OR "birth length*"[tiab] OR "fetal length*"[tiab] OR "fetal height*"[tiab] OR "fetus length*"[tiab] OR "fetus height*"[tiab] OR "crown-rump length*"[tiab] OR "crown rump length*"[tiab] OR **"Birth Weight"[Mesh] OR** "birth weight*"[tiab] OR "body mass*"[tiab] OR **"body size"[Mesh:NoExp]** OR "body size*"[tiab] OR **"Fetal Weight"[Mesh] OR** "fetal weight*"[tiab] **OR** "fetus weight*"[tiab] OR "**Body Weight"[Mesh:NoExp] OR** "body weight*"[tiab] OR **"Sagittal Abdominal Diameter"[Mesh]** OR "abdominal diameter*"[tiab] OR "abdominal circumference*"[tiab] OR "head circumference*"[tiab] OR "cranial circumference*"[tiab] OR "head diameter*"[tiab] OR "cranial diameter*"[tiab] OR **"Waist-Height Ratio"[Mesh]** OR "waist-height ratio*"[tiab] OR "waist height ratio*" [tiab] OR "waist to height ratio*" [tiab] OR "height to waist ratio*" [tiab] OR "height waist ratio*" [tiab] OR "height-waist ratio*" [tiab] OR "height weight ratio*" [tiab] OR "weight height ratio*" [tiab] OR "height-weight ratio*" [tiab] OR "weight-height ratio*" [tiab] OR "weight to height ratio*" [tiab] OR "height to weight ratio*" [tiab] OR **"Waist-Hip Ratio"[Mesh]** OR "waist-hip ratio*"[tiab] OR "waist hip ratio*" [tiab] OR "waist to hip ratio*" [tiab] OR "hip waist ratio*" [tiab] OR "hip-waist ratio*" [tiab] OR "hip to waist ratio*" [tiab] OR **"Anthropometry"[Mesh:NoExp]** OR "**Cephalometry"[Mesh]** OR "Cephalometr*"[tiab] OR **"Kinanthropometry"[Mesh]** OR "Kinanthropometr*"[tiab] OR "Anthropometr*"[tiab] OR **"Biometry"[Mesh:NoExp]** OR "Biometr*"[tiab] OR "Craniometr*"[tiab] OR "Osteometr*"[tiab] OR **"Growth Charts"[Mesh]** OR "Growth Chart*"[tiab] OR "Growth curve*"[tiab] OR "Body measurement*"[tiab])

EMBASE

('**infant'/exp** OR 'infant*':ti,ab,kw OR 'baby':ti,ab,kw OR 'babies':ti,ab,kw OR 'newborn*':ti,ab,kw OR 'neonate*':ti,ab,kw OR 'neonatal':ti,ab,kw OR 'recently born':ti,ab,kw OR **'fetus'/exp** OR 'fetus*':ti,ab,kw OR 'foetus*':ti,ab,kw OR 'feti':ti,ab,kw OR 'foeti':ti,ab,kw OR 'fetal':ti,ab,kw OR 'foetal':ti,ab,kw OR **'gestational age'/exp** OR 'gestational age':ti,ab,kw)

AND

('**particulate matter'/exp** OR 'particulate matter':ti,ab,kw OR '**particulate matter exposure**'**/exp** OR 'PM10':ti,ab,kw OR 'PM2.5':ti,ab,kw OR 'PM(10)':ti,ab,kw OR 'PM(2.5)':ti,ab,kw OR 'Particulate*':ti,ab,kw OR 'ultrafine fiber*':ti,ab,kw OR 'ultrafine particle*':ti,ab,kw OR 'black carbon*':ti,ab,kw OR **'air pollutant'/de** OR 'pollutant*':ti,ab,kw OR '**indoor air pollution**'**/exp** OR 'exhaust':ti,ab,kw OR '**greenhouse gas emission**'**/de** OR 'greenhouse gas*':ti,ab,kw OR '**air pollution**'**/exp** OR 'air pollution':ti,ab,kw OR 'flue gas*':ti,ab,kw OR 'smog':ti,ab,kw OR 'smoke':ti,ab,kw OR 'soot':ti,ab,kw OR 'vehicle emission*':ti,ab,kw OR 'vehicular emission*':ti,ab,kw OR 'car emission*':ti,ab,kw OR 'automobile emission*':ti,ab,kw OR 'transport* emission*':ti,ab,kw OR 'traffic emission*':ti,ab,kw OR **'ash'/de** OR 'ash':ti,ab,kw OR 'ashes':ti,ab,kw OR **'dust'/de** OR 'dust*':ti,ab,kw OR **'air quality'/exp** OR 'air quality':ti,ab,kw OR 'air monitoring':ti,ab,kw OR **'traffic pollution'/exp** OR 'traffic pollution':ti,ab,kw OR 'traffic-related pollution’:ti,ab,kw OR 'traffic related pollution’:ti,ab,kw OR **'atmospheric aerosol'/exp** OR 'atmospheric aerosol*':ti,ab,kw OR 'particle pollution':ti,ab,kw OR '**pollution transport**'**/exp** OR 'pollution NEAR/1 transport*':ti,ab,kw)

AND

('**fetus development**'**/de** OR 'fetus development':ti,ab,kw OR 'fetal development':ti,ab,kw OR **'fetus growth'/exp** OR 'fetus growth':ti,ab,kw OR 'fetal growth':ti,ab,kw OR **'body height'/exp** OR 'body height*':ti,ab,kw OR 'body length*':ti,ab,kw OR **'birth length'/exp** OR 'birth length*':ti,ab,kw OR 'fetal length*':ti,ab,kw OR 'fetal height*':ti,ab,kw OR 'fetus length*':ti,ab,kw OR 'fetus height*':ti,ab,kw OR **'body weight'/de** OR **'birth weight'/exp** OR **'fetus weight'/exp** OR 'body weight*':ti,ab,kw OR 'birth weight*':ti,ab,kw OR 'fetus weight*':ti,ab,kw OR 'fetal weight*':ti,ab,kw OR **'waist hip ratio'/exp** OR 'waist NEXT/1 hip ratio*':ti,ab,kw OR 'waist-hip ratio*':ti,ab,kw OR 'waist to hip ratio*':ti,ab,kw OR 'hip-waist ratio*':ti,ab,kw OR 'hip to waist ratio*':ti,ab,kw OR **'weight height ratio'/exp** OR 'weight NEXT/1 height ratio*':ti,ab,kw OR 'weight-height ratio*':ti,ab,kw OR 'height-weight ratio*':ti,ab,kw OR 'weight to height ratio*':ti,ab,kw OR 'height to weight ratio*':ti,ab,kw OR **'waist to height ratio'/exp** OR 'waist to height ratio*':ti,ab,kw OR 'height to waist ratio*':ti,ab,kw OR 'waist NEXT/1 height ratio*':ti,ab,kw OR 'waist-height ratio*':ti,ab,kw OR 'height-waist ratio*':ti,ab,kw OR **'body mass'/exp** OR 'body mass*':ti,ab,kw OR **'body size'/exp** OR 'body size*':ti,ab,kw OR '**biometry**'**/exp** OR 'biometry':ti,ab,kw OR 'biometrics'/exp OR '**anthropometric parameters**'**/de** OR '**abdominal circumference**'**/exp** OR 'abdominal circumference*':ti,ab,kw OR **'sagittal abdominal diameter'/exp** OR 'abdominal diameter*':ti,ab,kw OR **'crown rump length'/exp** OR 'crown rump length*':ti,ab,kw OR 'crown-rump length*':ti,ab,kw OR **'head circumference'/exp** OR 'head circumference*':ti,ab,kw OR 'cranial circumference*':ti,ab,kw OR **'head diameter'/exp** OR 'head diameter*':ti,ab,kw OR 'cranial diameter*':ti,ab,kw OR '**anthropometry**'**/de** OR 'anthropometr*':ti,ab,kw OR **'cephalometry'/exp** OR 'cephalometr*':ti,ab,kw OR **'craniometry'/exp** OR 'craniometr*':ti,ab,kw OR **'osteometry'/exp** OR 'osteometr*':ti,ab,kw OR **'kinanthropometry'/exp** OR 'kinanthropometr*':ti,ab,kw OR **'growth curve'/exp** OR 'growth curve*':ti,ab,kw OR 'growth chart*':ti,ab,kw OR 'body measurement*':ti,ab,kw)

WEB OF SCIENCE: CORE COLLECTION

TS=("Infant*" OR "Newborn*" OR "Neonate*" OR "Neonatal" OR "baby" OR "babies" OR "Recently born" OR "Fetus*" OR "Foetus*" OR "Feti" OR "foeti" OR "Fetal" OR "Foetal" OR "Gestational Age")

AND

TS=("particulate matter" OR "PM10" OR "PM2.5" OR "PM(10)" OR "PM(2.5)" OR "Particulate*" OR "ultrafine fiber*" OR "ultrafine particle*" OR "black carbon*" OR "pollutant*" OR "indoor air pollution" OR "exhaust" OR "greenhouse gas*" OR "air pollution" OR "flue gas*" OR "smog" OR "smoke" OR "soot" OR "vehicle emission*" OR "vehicular emission*" OR "car emission*" OR "automobile emission*" OR "transport* emission*" OR "traffic emission*" OR "ash" OR "ashes" OR "dust*" OR "air quality" OR "air monitoring" OR "traffic pollution" OR "traffic-related pollution" OR "traffic related pollution" OR "atmospheric aerosol*" OR "particle pollution" OR "pollution NEAR/1 transport*")

AND

TS=("fetus development" OR "fetal development" OR "fetus growth" OR "fetal growth" OR "body height*" OR "body length*" OR "birth length*" OR "fetal length*" OR "fetal height*" OR "fetus length*" OR "fetus height*" OR "body weight*" OR "birth weight*" OR "fetus weight*" OR "fetal weight*" OR "waist NEAR/1 hip ratio*" OR "waist-hip ratio*" OR "waist to hip ratio*" OR "hip-waist ratio*" OR "hip to waist ratio*" OR "weight NEAR/1 height ratio*" OR "weight-height ratio*" OR "height-weight ratio*" OR "weight to height ratio*" OR "height to weight ratio*" OR "waist to height ratio*" OR "height to waist ratio*" OR "waist NEAR/1 height ratio*" OR "waist-height ratio*" OR "height-waist ratio*" OR "body mass*" OR "body size*" OR "biometry" OR "biometrics" OR "abdominal circumference*" OR "abdominal diameter*" OR "crown rump length*" OR "crown-rump length*" OR "head circumference*" OR "cranial circumference*" OR "head diameter*" OR "cranial diameter*" OR "anthropometr*" OR "cephalometr*" OR "craniometr*" OR "osteometr*" OR "kinanthropometr*" OR "growth curve*" OR "growth chart*" OR "body measurement*")

COCHRANE LIBRARY

(**[mh "Infant"]** OR **[mh "Fetus"]** OR **[mh "Gestational Age"]** OR ("infant*" OR "Newborn*" OR "Neonate*" OR "Neonatal" OR "baby" OR "babies" OR "Recently born" OR "Fetus*" OR "Foetus*" OR "Feti" OR "Foeti" OR "Fetal" OR "Foetal" OR "Gestational Age"):ti,ab,kw)

AND

(**[mh** "**Particulate Matter"] OR [mh "Air Pollutants"]** OR **[mh** "**Air Pollutants, Occupational"]** OR **[mh** "**Greenhouse Gases"] OR [mh** "**Air Pollution"]** OR **[mh** "**Air Pollution, Indoor**"] OR **[mh** "**Vehicle Emissions"]** OR **[mh** "**Traffic-Related Pollution"] OR** ("Particulate Matter" OR "PM10" OR "PM(10)" OR "PM2.5" OR "PM(2.5)" OR (ultrafine NEXT fiber*) OR (ultrafine NEXT particle*) OR "Particulate*" OR "ash" OR "ashes" OR "dust*" OR "smog" OR "smoke" OR "soot" OR (black NEXT carbon*) OR "pollutant*" OR (greenhouse NEXT gas*) OR "air pollution" OR "air quality" OR (vehicle NEXT emission*) OR (vehicular NEXT emission*) OR (car NEXT emission*) OR (automobile NEXT emission*) OR (transport* NEXT emission*) OR (traffic NEXT emission*) OR "exhaust" OR "Traffic-Related Pollution" OR "Traffic Related Pollution" OR "traffic pollution" OR "particle pollution" OR (transport* NEXT pollution) OR (pollution NEXT transport*) OR (flue NEXT gas*) OR (atmospheric NEXT aerosol*) OR "air monitoring"):ti,ab,kw)

AND

([mh "Fetal Development"] OR **[mh "Body Height"]** OR **[mh "Birth Weight"]** OR **[mh "body size"]** OR **[mh "Fetal Weight"]** OR **[mh "Body Weight"]** OR **[mh "Sagittal Abdominal Diameter"]** OR **[mh "Waist-Height Ratio"]** OR **[mh "Anthropometry"]** OR **[mh "Cephalometry"]** OR **[mh "Waist-Hip Ratio"]** OR **[mh "Kinanthropometry"]** OR **[mh "Growth Charts"]** OR ("fetal development" OR "fetus development" OR "fetal growth" OR "fetus growth" OR (body NEXT height*) OR (body NEXT length*) OR (birth NEXT length*) OR (fetal NEXT length*) OR (fetal NEXT height*) OR (fetus NEXT length*) OR (fetus NEXT height*) OR (crown-rump NEXT length*) OR (crown NEXT rump NEXT length*) OR (birth NEXT weight*) OR (body NEXT mass*) OR (body NEXT size*) OR (fetal NEXT weight*) OR (fetus NEXT weight*) OR (body NEXT weight*) OR (abdominal NEXT diameter*) OR (abdominal NEXT circumference*) OR (head NEXT circumference*) OR (cranial NEXT circumference*) OR (head NEXT diameter*) OR (cranial NEXT diameter*) OR (waist-height NEXT ratio*) OR (waist NEAR/1 height NEXT ratio*) OR (waist NEXT to NEXT height NEXT ratio*) OR (height NEXT to NEXT waist NEXT ratio*) OR (height-waist NEXT ratio*) OR (height NEAR/1 weight NEXT ratio*) OR (height-weight NEXT ratio*) OR (weight-height NEXT ratio*) OR (weight NEXT to NEXT height NEXT ratio*) OR (height NEXT to NEXT weight NEXT ratio*) OR (waist-hip NEXT ratio*) OR (waist NEAR/1 hip NEXT ratio*) OR (waist NEXT to NEXT hip NEXT ratio*) OR (hip-waist NEXT ratio*) OR (hip NEXT to NEXT waist NEXT ratio*) OR "Cephalometr*" OR "Kinanthropometr*" OR "Anthropometr*" OR "Biometr*" OR "Craniometr*" OR "Osteometr*" OR (Growth NEXT Chart*) OR (Growth NEXT curve*) OR (Body NEXT measurement*)):ti,ab,kw)

CINAHL (via EBSCO)

(**(MH "Infant")** OR **(MH "Infant, Newborn+")** OR **(MH "Fetus")** OR **(MH "Gestational Age")** OR (**AB**("Infant*" OR "Newborn*" OR "Neonate*" OR "Neonatal" OR "baby" OR "babies" OR "Recently born" OR "Fetus*" OR "Foetus*" OR "Feti" OR "Foeti" OR "Fetal" OR "Foetal" OR "Gestational Age")) OR (**TI**("Infant*" OR "Newborn*" OR "Neonate*" OR "Neonatal" OR "baby" OR "babies" OR "Recently born" OR "Fetus*" OR "Foetus*" OR "Feti" OR "Foeti" OR "Fetal" OR "Foetal" OR "Gestational Age"))

AND

((**(MH "Particulate Matter+")** OR **(MH "Air Pollution+")** OR **(MH "Smog")** OR **(MH "Smoke")** OR **(MH "Air Pollutants, Occupational")** OR **(MH "Air Pollutants, Environmental")** OR **(MH "Greenhouse Gases")** OR **(MH "Motor Vehicle Emissions")** OR **(MH "Traffic Pollution+"))** OR (**AB**(“particulate matter” OR PM10 OR PM2.5 OR PM(10) OR PM(2.5) OR “Particulate*” OR “ultrafine fiber*” OR “ultrafine particle*” OR “black carbon*” OR “pollutant*” OR “indoor air pollution” OR “exhaust” OR “greenhouse gas*” OR “air pollution” OR “flue gas*” OR “smog” OR “smoke” OR “soot” OR “vehicle emission*” OR “vehicular emission*” OR “car emission*” OR “automobile emission*” OR “transport* emission*” OR “traffic emission*” OR “ash” OR “ashes” OR “dust*” OR “air quality” OR “air monitoring” OR “traffic pollution” OR “traffic-related pollution” OR “traffic related pollution” OR “atmospheric aerosol*” OR “particle pollution” OR “pollution NEAR/1 transport*”)) OR (**TI**(**“**particulate matter” OR PM10 OR PM2.5 OR PM(10) OR PM(2.5) OR “Particulate*” OR “ultrafine fiber*” OR “ultrafine particle*” OR “black carbon*” OR “pollutant*” OR “indoor air pollution” OR “exhaust” OR “greenhouse gas*” OR “air pollution” OR “flue gas*” OR “smog” OR “smoke” OR “soot” OR “vehicle emission*” OR “vehicular emission*” OR “car emission*” OR “automobile emission*” OR “transport* emission*” OR “traffic emission*” OR “ash” OR “ashes” OR “dust*” OR “air quality” OR “air monitoring” OR “traffic pollution” OR “traffic-related pollution” OR “traffic related pollution” OR “atmospheric aerosol*” OR “particle pollution” OR “pollution NEAR/1 transport*”)))

AND

(**(MH "Fetal Development")** OR **(MH "Fetal Weight")** OR **(MH "Body Weight")** OR **(MH "Birth Weight")** OR **(MH "Body Height")** OR **(MH "Anthropometry")** OR **(MH "Cephalometry")** OR **(MH "Body Size")** OR **(MH "Crown-Rump Length")** OR **(MH "Head Circumference")** OR **(MH "Waist-Hip Ratio")** OR **(MH "Biometrics")** OR **(MH "Body Weights and Measures")** OR (**AB** (“fetus development” OR “fetal development” OR “fetus

growth” OR “fetal growth” OR “body height*” OR “body length*” OR “birth length*” OR “fetal length*” OR “fetal height*” OR “fetus length*” OR “fetus height*” OR “body weight*” OR “birth weight*” OR “fetus weight*” OR “fetal weight*” OR “waist NEAR/1 hip ratio*” OR “waist-hip ratio*” OR “waist to hip ratio*” OR “hip-waist ratio*” OR “hip to waist ratio*” OR “weight NEAR/1 height ratio*” OR “weight-height ratio*” OR “height-weight ratio*” OR “weight to height ratio*” OR “height to weight ratio*” OR “waist to height ratio*” OR “height to waist ratio*” OR “waist NEAR/1 height ratio*” OR “waist-height ratio*” OR “height-waist ratio*”OR “body mass*” OR “body size*” OR “biometry” OR “biometrics” OR “abdominal circumference*” OR “abdominal diameter*” OR “crown rump length*” OR “crown-rump length*” OR “head circumference*” OR “cranial circumference*” OR “head diameter*” OR “cranial diameter*” OR “anthropometr*” OR “cephalometr*” OR “craniometr*” OR “osteometr*” OR “kinanthropometr*” OR “growth curve*” OR “growth chart*” OR “body measurement*”)) OR (**TI** (“fetus development” OR “fetal development” OR “fetus growth” OR “fetal growth” OR “body height*” OR “body length*” OR “birth length*” OR “fetal length*” OR “fetal height*” OR “fetus length*” OR “fetus height*” OR “body weight*” OR “birth weight*” OR “fetus weight*” OR “fetal weight*” OR “waist NEAR/1 hip ratio*” OR “waist-hip ratio*” OR “waist to hip ratio*” OR “hip-waist ratio*” OR “hip to waist ratio*” OR “weight NEAR/1 height ratio*” OR “weight-height ratio*” OR “height-weight ratio*” OR “weight to height ratio*” OR “height to weight ratio*” OR “waist to height ratio*” OR “height to waist ratio*” OR “waist NEAR/1 height ratio*” OR “waist-height ratio*” OR “height-waist ratio*”OR “body mass*” OR “body size*” OR “biometry” OR “biometrics” OR “abdominal circumference*” OR “abdominal diameter*” OR “crown rump length*” OR “crown-rump length*” OR “head circumference*” OR “cranial circumference*” OR “head diameter*” OR “cranial diameter*” OR “anthropometr*” OR “cephalometr*” OR “craniometr*” OR “osteometr*” OR “kinanthropometr*” OR “growth curve*” OR “growth chart*” OR “body measurement*”))

WEB OF SCIENCE - BIOSIS

(AB=("Infant*" OR "Newborn*" OR "Neonate*" OR "Neonatal" OR "baby" OR "babies" OR "Recently born" OR "Fetus*" OR "Foetus*" OR "Feti" OR "foeti" OR "Fetal" OR "Foetal" OR "Gestational Age")) OR (**TI**=("Infant*" OR "Newborn*" OR "Neonate*" OR "Neonatal" OR "baby" OR "babies" OR "Recently born" OR "Fetus*" OR "Foetus*" OR "Feti" OR "foeti" OR "Fetal" OR "Foetal" OR "Gestational Age"))

AND

(**AB**=("particulate matter" OR "PM10" OR "PM2.5" OR "PM(10)" OR "PM(2.5)" OR "Particulate*" OR "ultrafine fiber*" OR "ultrafine particle*" OR "black carbon*" OR "pollutant*" OR "indoor air pollution" OR "exhaust" OR "greenhouse gas*" OR "air pollution" OR "flue gas*" OR "smog" OR "smoke" OR "soot" OR "vehicle emission*" OR "vehicular emission*" OR "car emission*" OR "automobile emission*" OR "transport* emission*" OR "traffic emission*" OR "ash" OR "ashes" OR "dust*" OR "air quality" OR "air monitoring" OR "traffic pollution" OR "traffic-related pollution" OR "traffic related pollution" OR "atmospheric aerosol*" OR "particle pollution" OR "pollution NEAR/1 transport*")) OR (**TI**=("particulate matter" OR "PM10" OR "PM2.5" OR "PM(10)" OR "PM(2.5)" OR "Particulate*" OR "ultrafine fiber*" OR "ultrafine particle*" OR "black carbon*" OR "pollutant*" OR "indoor air pollution" OR "exhaust" OR "greenhouse gas*" OR "air pollution" OR "flue gas*" OR "smog" OR "smoke" OR "soot" OR "vehicle emission*" OR "vehicular emission*" OR "car emission*" OR "automobile emission*" OR "transport* emission*" OR "traffic emission*" OR "ash" OR "ashes" OR "dust*" OR "air quality" OR "air monitoring" OR "traffic pollution" OR "traffic-related pollution" OR "traffic related pollution" OR "atmospheric aerosol*" OR "particle pollution" OR "pollution NEAR/1 transport*"))

AND

(**AB**=("fetus development" OR "fetal development" OR "fetus growth" OR "fetal growth" OR "body height*" OR "body length*" OR "birth length*" OR "fetal length*" OR "fetal height*" OR "fetus length*" OR "fetus height*"

OR "body weight*" OR "birth weight*" OR "fetus weight*" OR "fetal weight*" OR "waist NEAR/1 hip ratio*" OR "waist-hip ratio*" OR "waist to hip ratio*" OR "hip-waist ratio*" OR "hip to waist ratio*" OR "weight NEAR/1 height ratio*" OR "weight-height ratio*" OR "height-weight ratio*" OR "weight to height ratio*" OR "height to weight ratio*" OR "waist to height ratio*" OR "height to waist ratio*" OR "waist NEAR/1 height ratio*" OR "waist-height ratio*" OR "height-waist ratio*" OR "body mass*" OR "body size*" OR "biometry" OR "biometrics" OR "abdominal circumference*" OR "abdominal diameter*" OR "crown rump length*" OR "crown-rump length*" OR "head circumference*" OR "cranial circumference*" OR "head diameter*" OR "cranial diameter*" OR "anthropometr*" OR "cephalometr*" OR "craniometr*" OR "osteometr*" OR "kinanthropometr*" OR "growth curve*" OR "growth chart*" OR "body measurement*")) OR (**TI**=("fetus development" OR "fetal development" OR "fetus growth" OR "fetal growth" OR "body height*" OR "body length*" OR "birth length*" OR "fetal length*" OR "fetal height*" OR "fetus length*" OR "fetus height*" OR "body weight*" OR "birth weight*" OR "fetus weight*" OR "fetal weight*" OR "waist NEAR/1 hip ratio*" OR "waist-hip ratio*" OR "waist to hip ratio*" OR "hip-waist ratio*" OR "hip to waist ratio*" OR "weight NEAR/1 height ratio*" OR "weight-height ratio*" OR "height-weight ratio*" OR "weight to height ratio*" OR "height to weight ratio*" OR "waist to height ratio*" OR "height to waist ratio*" OR "waist NEAR/1 height ratio*" OR "waist-height ratio*" OR "height-waist ratio*" OR "body mass*" OR "body size*" OR "biometry" OR "biometrics" OR "abdominal circumference*" OR "abdominal diameter*" OR "crown rump length*" OR "crown-rump length*" OR "head circumference*" OR "cranial circumference*" OR "head diameter*" OR "cranial diameter*" OR "anthropometr*" OR "cephalometr*" OR "craniometr*" OR "osteometr*" OR "kinanthropometr*" OR "growth curve*" OR "growth chart*" OR "body measurement*"))

SCOPUS

TITLE-ABS-KEY ("Infant*" OR "Newborn*" OR "Neonate*" OR "Neonatal" OR "baby" OR "babies" OR "Recently born" OR "Fetus*" OR "Foetus*" OR "Feti" OR "Foeti" OR "Fetal" OR "Foetal" OR "Gestational Age")

AND

TITLE-ABS-KEY ("Particulate Matter" OR "PM10" OR "PM(10) " OR "PM2.5" OR "PM(2.5) " OR "ultrafine fiber*" OR "ultrafine particle*" OR "Particulate*" OR "ash" OR "ashes" OR "dust*" OR "smog" OR "smoke" OR "soot" OR "black carbon*" OR **"Air Pollutants"** OR "**Air Pollutants, Occupational"** OR "pollutant*" OR "greenhouse gas*" OR "**Air Pollution, Indoor**" OR "air pollution" OR "air quality" OR "vehicle emission*" OR "vehicular emission*" OR "car emission*" OR "automobile emission*" OR "transport* emission*" OR "traffic emission*" OR "exhaust" OR "Traffic-Related Pollution" OR "Traffic Related Pollution" OR "traffic pollution" OR "particle pollution" OR "transport W/1 pollution" OR "transportation W/1 pollution" OR "flue gas*" OR "atmospheric aerosol*" OR "air monitoring")

AND

TITLE-ABS-KEY ("fetal development" OR "fetus development" OR "fetal growth" OR "fetus growth" OR "body height*" OR "body length*" OR "birth length*" OR "fetal length*" OR "fetal height*" OR "fetus length*" OR "fetus height*" OR "crown-rump length*" OR "crown rump length*" OR "birth weight*" OR "body mass*" OR "body size*" OR "fetal weight*" OR "fetus weight*" OR "body weight*" OR "abdominal diameter*" OR "abdominal circumference*" OR "head circumference*" OR "cranial circumference*" OR "head diameter*" OR "cranial diameter*" OR "waist W/1 hip ratio*" OR "waist-hip ratio*" OR "waist to hip ratio*" OR "hip-waist ratio*" OR "hip to waist ratio*" OR "weight W/1 height ratio*" OR "weight-height ratio*" OR "height-weight ratio*" OR "weight to height ratio*" OR "height to weight ratio*" OR "waist to height ratio*" OR "height to waist ratio*" OR "waist NEAR/1 height ratio*" OR "waist-height ratio*" OR "height-waist ratio*" OR "Cephalometr*" OR "Kinanthropometr*" OR "Anthropometr*" OR "Biometr*" OR "Craniometr*" OR "Osteometr*" OR "Growth Chart*" OR "Growth curve*" OR "Body measurement*")

GREENFILE (via EBSCO)

(DE "CHILDREN & the environment") OR (**AB** (Infant* OR Newborn* OR Neonate* OR Neonatal OR baby OR babies OR “Recently born” OR Fetus* OR Foetus* OR Feti OR Foeti OR Fetal OR Foetal OR “Gestational Age”)) OR (**TI** (Infant* OR Newborn* OR Neonate* OR Neonatal OR baby OR babies OR “Recently born” OR Fetus* OR Foetus* OR Feti OR Foeti OR Fetal OR Foetal OR “Gestational Age”)) OR (**KW** (Infant* OR Newborn* OR Neonate* OR Neonatal OR baby OR babies OR “Recently born” OR Fetus* OR Foetus* OR Feti OR Foeti OR Fetal OR Foetal OR “Gestational Age”))

AND

(DE "EFFECT of air pollution on human beings" OR DE "PARTICULATE matter" OR DE "DUST" OR DE "DUST & the environment" OR DE “SOOT" OR DE “SMOG” OR DE “SMOKE” OR DE "AIR pollution" OR DE "INDOOR air pollution" OR DE "AIR pollutants" OR DE "GREENHOUSE gases" OR DE "GREENHOUSE gases & the environment" OR DE "AIR quality" OR DE "AIR quality & the environment" OR DE "AIR quality monitoring" OR DE "AUTOMOBILE emissions" OR DE "AIR pollution transport" OR DE "FLUE gases" OR DE "ATMOSPHERIC aerosols" OR DE "ATMOSPHERIC aerosols & the environment" OR DE "AIR pollution measurement" OR DE "AIR pollution monitoring" OR DE "EMISSIONS (Air pollution)") OR (**AB** ("Particulate Matter" OR "PM10" OR "PM(10)" OR "PM2.5" OR "PM(2.5)" OR "ultrafine fiber*" OR "ultrafine particle*" OR Particulate* OR ash OR ashes OR dust* OR smog OR smoke OR soot OR "black carbon*" OR pollutant* OR "greenhouse gas*" OR "air pollution" OR "air quality" OR "vehicle emission*" OR "Vehicular Emission*" OR “car emission*” OR “automobile emission*” OR "transport* emission*" OR "traffic emission*" OR "Traffic-Related Pollution" OR "Traffic Related Pollution" OR "traffic pollution" OR "transport* N1 pollution" OR "exhaust" OR "flue gas*" OR "particle pollution" OR "atmospheric aerosol*" OR "air monitoring")) OR (**TI** ("Particulate Matter" OR "PM10" OR "PM(10)" OR "PM2.5" OR "PM(2.5)" OR "ultrafine fiber*" OR "ultrafine particle*" OR Particulate* OR ash OR ashes OR dust* OR smog OR smoke OR soot OR "black carbon*" OR pollutant* OR "greenhouse gas*" OR "air pollution" OR "air quality" OR "vehicle emission*" OR "Vehicular Emission*" OR “car emission*” OR “automobile emission*” OR "transport* emission*" OR "traffic emission*" OR "Traffic-Related Pollution" OR "Traffic Related Pollution" OR "traffic pollution" OR "transport* N1 pollution" OR "exhaust" OR "flue gas*" OR "particle pollution" OR "atmospheric aerosol*" OR "air monitoring")) OR (**KW** ("Particulate Matter" OR "PM10" OR "PM(10)" OR "PM2.5" OR "PM(2.5)" OR "ultrafine fiber*" OR "ultrafine particle*" OR Particulate* OR ash OR ashes OR dust* OR smog OR smoke OR soot OR "black carbon*" OR pollutant* OR "greenhouse gas*" OR "air pollution" OR "air quality" OR "vehicle emission*" OR "Vehicular Emission*" OR “car emission*” OR “automobile emission*” OR "transport* emission*" OR "traffic emission*" OR "Traffic-Related Pollution" OR "Traffic Related Pollution" OR "traffic pollution" OR "transport* N1 pollution" OR "exhaust" OR "flue gas*" OR "particle pollution" OR "atmospheric aerosol*" OR "air monitoring"))

AND

(**AB** ("fetal development" OR "fetus development" OR "fetal growth" OR "fetus growth" OR "body height*" OR "body length*" OR "birth length*" OR "fetal length*" OR "fetal height*" OR "fetus length*" OR "fetus height*" OR "crown-rump length*" OR "crown rump length*" OR "birth weight*" OR "body mass*" OR "body size*" OR "fetal weight*" OR "fetus weight*" OR "body weight*" OR "abdominal diameter*" OR "abdominal circumference*" OR "head circumference*" OR "cranial circumference*" OR "head diameter*" OR "cranial diameter*" OR "waist N1 hip ratio*" OR "waist-hip ratio*" OR "waist to hip ratio*" OR "hip-waist ratio*" OR "hip to waist ratio*" OR "weight N1 height ratio*" OR "weight-height ratio*" OR "height-weight ratio*" OR "weight to height ratio*" OR "height to weight ratio*" OR "waist to height ratio*" OR "height to waist ratio*" OR "waist N1 height ratio*" OR "waist-height ratio*" OR "height-waist ratio*" OR "Cephalometr*" OR "Kinanthropometr*" OR "Anthropometr*" OR "Biometr*" OR "Craniometr*" OR "Osteometr*" OR "Growth

Chart*" OR "Growth curve*" OR "Body measurement*")) OR (**TI** ("fetal development" OR "fetus development" OR "fetal growth" OR "fetus growth" OR "body height*" OR "body length*" OR "birth length*" OR "fetal length*" OR "fetal height*" OR "fetus length*" OR "fetus height*" OR "crown-rump length*" OR "crown rump length*" OR "birth weight*" OR "body mass*" OR "body size*" OR "fetal weight*" OR "fetus weight*" OR "body weight*" OR "abdominal diameter*" OR "abdominal circumference*" OR "head circumference*" OR "cranial circumference*" OR "head diameter*" OR "cranial diameter*" OR "waist N1 hip ratio*" OR "waist-hip ratio*" OR "waist to hip ratio*" OR "hip-waist ratio*" OR "hip to waist ratio*" OR "weight N1 height ratio*" OR "weight-height ratio*" OR "height-weight ratio*" OR "weight to height ratio*" OR "height to weight ratio*" OR "waist to height ratio*" OR "height to waist ratio*" OR "waist N1 height ratio*" OR "waist-height ratio*" OR "height-waist ratio*" OR "Cephalometr*" OR "Kinanthropometr*" OR "Anthropometr*" OR "Biometr*" OR "Craniometr*" OR "Osteometr*" OR "Growth Chart*" OR "Growth curve*" OR "Body measurement*")) OR (**KW** ("fetal development" OR "fetus development" OR "fetal growth" OR "fetus growth" OR "body height*" OR "body length*" OR "birth length*" OR "fetal length*" OR "fetal height*" OR "fetus length*" OR "fetus height*" OR "crown-rump length*" OR "crown rump length*" OR "birth weight*" OR "body mass*" OR "body size*" OR "fetal weight*" OR "fetus weight*" OR "body weight*" OR "abdominal diameter*" OR "abdominal circumference*" OR "head circumference*" OR "cranial circumference*" OR "head diameter*" OR "cranial diameter*" OR "waist N1 hip ratio*" OR "waist-hip ratio*" OR "waist to hip ratio*" OR "hip-waist ratio*" OR "hip to waist ratio*" OR "weight N1 height ratio*" OR "weight-height ratio*" OR "height-weight ratio*" OR "weight to height ratio*" OR "height to weight ratio*" OR "waist to height ratio*" OR "height to waist ratio*" OR "waist N1 height ratio*" OR "waist-height ratio*" OR "height-waist ratio*" OR "Cephalometr*" OR "Kinanthropometr*" OR "Anthropometr*" OR "Biometr*" OR "Craniometr*" OR "Osteometr*" OR "Growth

Appendix 2 – Table of findings: summary of results from included studies

Author, Year	Study design	Location and data collection period	Population size (N)	Outcomes	Exposure window	Air pollutants	Main findings/results	Conclusion
Palma A., 2022	Retrospective cohort study	Italy 2002-2008	Not mentioned	BW, LBW, VLBW, IUGR	TP, T1, T2, T2	PM10	**BW:** **TP: -18.420g (=-0.5%)** **T1: -8.402g (=-0.25%)** **T2: 11.381g (= +0.35%)** **T3: -28.409g (= -0.87%)** **LBW prevalence:** **TP: +22%** **T1: +10%** **T2: -16%** **T3: +38%** **VLBW: not significant** **IUGR: not significant** **per increase of 10 µg/m3 PM10**	An increase in PM10 concentration results in a lower BW and a higher risk of LBW. VLWB and IUGR are not affected. The effects are stronger in the third trimester. Effects in the 2nd trimester are not significant.
Chen Y., 2021	Population-based cohort study	South-West England, 1990-1992	12020 live births	BW, HC, BL, TLBW, SGA	T1, T2, T3 and TP	PM10	BW TP: 0.89gr [95%CI -13.61, 15.38] HC TP: 0.03cm [95%CI -0.02, 0.07] T1 **0.10cm [95%CI 0.04, 0.15]** BL TP **0.10cm [95CI% 0.03, 0.18]** T1 **0.15cm [95%CI 0.06, 0.23]** TLBW TP OR: 1.11 [95%CI 0.88, 1.40] T3 **OR: 1.40 [95%CI 1.12, 1.75]** SGA TP OR: 1.05 [95%CI 0.93, 1.17] T3 **OR: 1.18 [95%CI 1.05, 1.32]** per IQR increase	PM10 exposures affects birth weight, with greatest effect in the third trimester
Liu Z., 2021	Prospective cohort	Sweden and Washington State, 1996 - 2008	855 women	BW	Trimester-specific and by month exposure	PM2.5	**T3: +102.75 g [95%CI 70.65, 134.85]** **4th month: -66.34g [95%CI -126.61, -6.08]** **per 5 µg/m3 PM2.5 exposure**	Higher T3 exposure was associated wit higher BW. Higher fourth month exposure was associated with lower BW
Ouidir M., 2021	Cohort study	France 2011	13 334 women	TBW	T1, T2, T3	PM10, PM2.5	T1: **PM2.5: increase** (data?) **PM10: increase** (data?) T2: **PM2.5: -12.3g** [**95%CI -22.4, -2.2]** PM10: -6.9g [95%CI -15.9, 2.1] T3: **PM2.5: -27.0g [95%CI -36.6, -17.4]** **PM10: -26.9g [95%CI -36.6, -17.6]** per increase of 5µg/m3	Exposure to PM2.5 and PM10 during the second an third trimester has an adverse effect on TBW.

Author, Year	Study design	Location and data collection period	Population size (N)	Outcomes	Exposure window	Air pollutants	Main findings/results	Conclusion
Balogun H.A., 2020	Cohort study	Espoo, Finland 1984-1990	2568 children	LBW	TP	PM10, PM2.5	LBW<3000g: PM2.5: RR 0.89 [95%CI 0.69, 1.16] PM10: RR 0.86 [95%CI 0.66, 1.11] LBW<2500g: PM2.5: RR 1.39 [95%CI 0.88, 2.20] PM10: RR 1.26 [95%CI 0.79, 2.00] in the highest quartile of exposure (Q4)	No increased risk could be shown for LBW<3000g nor <2500g with PM2.5 or PM10 exposure.
Bergstra A.D., 2020	Cross sectional study	Netherlands 2012-2017	4488 births	LBW, SGA, BW, BL, HC	TP	PM10	LBW: OR 1.10 [95%CI 0.94, 1.29] SGA: OR 1.04 95%CI 0.95, 1.14] **BW: -15.85g [95%CI -28.26, -3.45]** **BL: -0.12cm [95%CI -0.19, -0.04]** **HC: - 0.09 [95%CI -0.14, -0.04]** Per PM10 increase of 0.41µg/m3	PM10 exposure is associated with a decrease in BW, BL and HC.
De Bont, J., 2020	Prospective longitudal cohort study	(Urban areas of) Catalonia, 2011-2012	79 992 children	BMI	0-5 year	PM2.5, PM10	PM2.5: 0-2 months: -0.042 [95%CI -0.089, 0.004] 2-6 months: -0.020 [95%CI -0.041, 0.001] PM10: 0-2months: **0.096 [95%CI 0.020, 0.172]** 2-6months: -0.033 [95% CI -0.066, 0.001] per increase of 1 IQR exposure	PM10 is associated with small increased BMI growth during the first 2 months of life
Ottone M., 2020	Open (residential) cohort study	Northern Italy, 2012 - 2014	23,708 neonates	LBW, SGA	From fertilization to delivery	PM2.5	LBW: OR 1,006 [95%CI 0.96, 1.05] SGA: OR 0,988 [95%CI 0.97, 1.01]	No association between LBW or SGA and PM2.5
Wojtyla C., 2020	Population based cohort study	Poland 2/2/2017-22-3/2017	1095 women	BW, BL, LBW	TP	PM2.5	**BW: -115g** **BL: -0.4cm** **LBW: OR 4.3 [95%CI 1.5, 12.3] with PM2.5 >25µg/m3 compared to below this cut-off**	PM2.5 is associated with a lower BW and an increased risk of LBW.
Arroyo V., 2019	Longitudal ecological study	Spain, 2001-2009	The population of Spain	LBW	TP	PM10	**RR: 1.104 [95%CI 1.072, 1.138]** **PAR: 9,42% [95%CI 6.72, 19.22]** **per increase of 10µg/m3**	5% of low birth weight births could have been avoided with a reduction of 10 µg/m3 PM10
Ghosh R.E., 2018	Retrospective population-based cohort	UK 2003-2010	1 025 064 births	TBW, SGA	TP	PM10	TBW 0,12g [95%CI -1.51, 1.75] SGA OR 0.99 [95%CI 0.98, 1.00] per doubling of PM10	PM10 concentration from municipal waste incinerator emissions is not associated with adverse birth or fetal growth outcomes.
Giovannini N., 2018	Prospective cohort study	Lombardia region, Italy 2004-2006	3616 women	BW	T1, T2, T3	PM10	BW: **T1: -22.2g [95%CI -35.7, -8.7]** T2: -10.1g [95%CI -24.2, 4.0] T3: - 5.1g [95%CI -18.4, 8.2] per 10µg/m3 increase in PM10	BW was negatively associated with exposure to PM10 concentration during the 1st trimester.

Author, Year	Study design	Location and data collection period	Population size (N)	Outcomes	Exposure window	Air pollutants	Main findings/results	Conclusion
Manangama G., 2018	Longitudal cohort study	France, 2011	11,224 mothers and singleton birth pairs	SGA	TP	NPs	**ORa 1.63 [95%CI 1.22, 2.18]**	Significant association between maternal occupational exposure to NPs and SGA
Clemens T., 2017	Observational population based cohort study	North-East Scotland, 2002-2011	13,775 pregnancies	In utero: BPD, FL and AC birth outcomes: BW, CHL and OFC	Throughout the second half of pregnancy and at birth	PM2.5, PM10	BPD: PM2.5: **-2.18mm at 36w** PM10: **-2.28mm at 36w** CHL: PM2.5: **-0.23cm [95%CI -0.40, -0.05]** PM10: **-0.22cm [95%CI -0.42, -0.01]** per 5µg/m3 increase OFC: PM2.5: -**0.14cm [95%CI -0.25, -0.02]** PM10: -**0.16cm [95%CI -0.29, -0.02]** per 5µg/m3 increase FL, AC, BW: not significant	Fetal growth is strongly associated with particulate exposure from later in second trimester (+/- 25w) onwards and at birth
Jedrychowski W.A., 2017	Prospective cohort	Krakow 2000-2004	455 neonates	BW, BL, HC	T2	PM2.5 (PAH)	**BW: -78.83g** **BL: -0.54cm** **HC: -0.30cm** **per increase of 1 Ln unit of PM2.5 (µg/m3)**	PM2.5 is inversely associated with all birth outcomes.
Smith R.B., 2017	Retrospective population-based cohort study	Greater London and surrounding countries up to the M25 motorway (2317 km2), UK, 2006 to 2010	540 365 singleton term live births	TLBW, SGA	TP	PM2.5, PM10	TLBW: **PM2.5: OR 1.06 [95%CI 1.01, 1.12]** PM10: OR 1.03 [95%CI 0.99, 1.07] SGA: PM2.5: OR 1.03 [95%CI 1.00, 1.06] PM10: OR 1.00 [95%CI 0.98, 1.03]	Air pollution from road traffic in London is adversely affecting fetal growth.

All significant results are expressed in bold

Abbreviations: *BW = birth weight, TBW = term birth weight, HC = head circumference, AC = abdominal circumference, BPD = bi-parietal diameter, FL = femur length, BL = birth length, CHL = crown heel length, OFC = occipitofrontal circumference, LBW = low birth weight, TLBW = term low birth weight, VLBW = very low birth weight, SGA = small for gestational age, BMI = body mass index, IUGR = intra-uterine growth restriction, T1 = first trimester, T2 = second trimester, T3 = third trimester, TP = total pregnancy, NPs = nanoscale particles, Q1/2/3/4 = quartile 1/2/3/4, RR = relatieve risk, PAR = population attributable risk, OR = odds ratio, ORa = adjusted odds ratio*

Appendix 3 – JBI critical appraisal tool

JBI critical appraisal tool checklist for cohort studies

Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Total (/11)
Liu Z., 2021	Y	Y	Y	Y	Y	Y	Y	Y	Y	U[8]	Y	10,5
Chen Y., 2021	Y	Y	Y	Y	Y	Y	Y	Y	U[7]	U[8]	Y	10
Ottone M., 2020	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	11
de Bont, J., 2020	Y	Y	Y	Y	Y	Y	Y	Y	Y	U[8]	Y	10,5
Manangama G., 2018	N[1]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
Clemens T., 2017	Y	Y	Y	Y	Y	Y	Y	Y	U[7]	U[8]	U[9]	9,5
Smith R.B., 2017	Y	Y	Y	N[3]	Y	Y	Y	Y	Y	Y	Y	10
Jedrychowski W.A., 2017	Y	Y	Y	Y	Y	Y	Y	Y	U[7]	U[8]	U[9]	9,5
Giovannini N., 2018	Y	Y	Y	N[3]	Y	Y	Y	Y	U[7]	U[8]	U[9]	8,5
Ghosh R.E., 2018	Y	Y	Y	N[3]	Y	Y	Y	Y	U[7]	U[8]	Y	9
Balogun H.A., 2020	Y	Y	Y	N[3]	Y	Y	N[5]	Y	U[7]	Y	Y	8,5
Wojtyla C., 2020	Y	Y	N[2]	Y	Y	Y	Y	Y	U[7]	U[8]	U[9]	8,5
Ouidir M., 2021	Y	Y	Y	Y	Y	Y	N[6]	Y	Y	Y	Y	10
Palma A., 2022	Y	Y	Y	N[3 4]	Y	Y	Y	Y	U[7]	U[8]	U[9 10]	8,5

JBI critical appraisal tool checklist for analytical cross sectional studies

Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total (/8)
Bergstra A.D., 2020	Y	Y	Y	Y	Y	Y	Y	Y	8
Arroyo V., 2019	N[11]	N[11]	Y	Y	N[12]	N[12]	Y	U[9]	3,5

Abbreviations: Y = Yes (+ 1 point), N = No (= 0 points), U = Unclear (= + 0.5 point)

Comments to the table:

[1] Exposed group is too small (only 5% of total sample size)

[2] Exposure is based on hospital location

[3] Maternal smoking is not considered as a confounding factor

[4] Gestational age is not considered as a confounding factor

[5] LBW is defined as weight < 3000 gr

[6] Data collected in unreliable way (by interview at birth)

[7] Loss to follow-up is not discussed

[8] Strategies to address loss to follow-up are not discussed

[9] Missing data are not discussed

[10] Statistical method is not comprehensible to the average reader

[11] In-/exclusion criteria and population characteristics are not mentioned

[12] No confounders taken into account

Wat is de impact van fijnstof op de ontwikkeling tijdens de zwangerschap en groei van het kind pre-en postnataal.

Dossiernr.:	MP018570
Masterproef:	Masterproef I HAIO, 2020 – 2023
Faculteit/opleiding:	Faculteit Geneeskunde - Master in de huisartsgeneeskunde
Studiefase:	eerste fase
Academiejaar:	2021-2022
Korte omschrijving / abstract:	Naar aanleiding van het doctoraatsonderzoek van Simon Beerten over het effect van urbanisatiefactoren (hittestress, geluidsoverlast, luchtvervuiling en aanwezigheid van groen) op gezondheid in Vlaanderen, werken wij met een groep van 8 HAIO's per twee telkens een deelonderwerp uit. Ons systematisch literatuuronderzoek gaat over de impact van fijnstof op de ontwikkeling en groei van het kind tijdens en na de zwangerschap.
Gewenste taal van communicatie:	nl
Promotor:	Dr. Gijs Van Pottelbergh (u0064216)
Copromotor:	Dr. Simon Beerten (u0139523)
Organisatie:	KU Leuven
Dienst:	Academisch Centrum voor Huisartsgeneeskunde
Discipline:	Masterproef
Extra groepsleden:	Julie Bollen julie.bollen@student.kuleuven.be r0595363 Karen Dilissen karen.dilissen@student.kuleuven.be r0462963

De verstrekte informatie toont aan dat het onderzoek in het kader van de masterproef een zuivere literatuurstudie betreft en dat er op geen enkele wijze gebruik wordt gemaakt van proefdieren, proefpersonen of menselijk lichaamsmateriaal.

Dit type onderzoek vereist geen goedkeuring van een gemachtigde commissie voor medische ethiek.

Onder voorbehoud van de volledigheid en correctheid van de door u verstrekte gegevens, krijgt u hierbij het akkoord om het onderzoek in het kader van de masterproef te starten. Deze mail dient als bewijs van goedkeuring mocht u uw onderzoek wensen te publiceren.

Wij willen u erop attent maken dat u zelf verantwoordelijk blijft voor uw onderzoek. Bovendien doet elke wijziging aan de door u verstrekte gegevens omtrent de onderzoeksopzet deze goedkeuring vervallen. U dient in dat geval een amendement te maken aan uw huidig dossier.

Vragen en antwoorden

Vragen	Antwoorden
De masterproef bestaat uitsluitend uit een literatuurstudie.	ja
Confirmatie stap	ja

SCONE is het platform voor stages, masterproeven en keuzevakken van de KU Leuven Groep Biomedische Wetenschappen

KU LEUVEN

ADDENDUM Reflectie – Bollen Julie

Milieu-invloeden op gezondheid vind ik een boeiend thema waar pas de laatste jaren meer onderzoek naar wordt verricht, maar m.i. nog veel meer aandacht aan mag gegeven worden. Met name milieu-invloeden gerelateerd aan de verstedelijkte context prikkelen mijn interesse (te meer omdat ik zelf woon in het centrum van Antwerpen). Daarnaast vind ik ook de foetale en neonatale fase bijzonder interessant, zie ook mijn masterthesis over gebruik van amoxicilline-clavulaanzuur bij de neonaat. Het thema van dit onderzoek sprak me dan ook meteen aan. Het concept fijnstof vergde nog wat verdiepend opzoek- en inleeswerk, gezien dit voor mij toch niet tot de parate kennis behoorde. Dit maakte het net een extra boeiend topic.

De keuze voor een systematic review was een positieve keuze. Mijn interesse ligt namelijk eerder bij academisch/theoretisch werk, dan bij praktijkprojecten of surveys afnemen.

Omdat milieu-invloeden zo divers zijn en vaak ook samen hun invloed uitoefenen, was het boeiend om met onze thesis deel uit te maken van een groter onderzoek dat naar verschillende aspecten van milieu en gezondheid kijkt. We zijn begonnen als een groep van 8 HAIO's die vervolgens per twee een deelonderwerp van dit brede thema hebben uitgewerkt. Deze 4 onderzoeken bekijken alle de impact van een milieu-/omgevingsfactor op een aspect van gezondheid. Onze thesis werd begeleid door co-promotor Simon Beerten die zijn doctoraatsonderzoek doet over het effect van urbanisatiefactoren op mentale gezondheid in Vlaanderen.

Het proces tot het eindresultaat is in verschillende fasen en versnellingen tot stand gekomen. Over de 3 jaar dat we de tijd hadden, is er tijdens het laatste jaar het meeste werk verzet. Ik denk dat dit een logisch gevolg is van het feit dat het eerste jaar als HAIO al enorm pittig is qua aanpassing en werkdruk. En dit des te meer voor onze lichting, die in oktober 2020 in volle covidpandemie de start heeft moeten maken. Gedurende het laatste jaar kwam er meer tijd vrij op dinsdagen en werd dit de vaste thesisdag. Een fijne afwisseling met het klinisch werken vond ik.

Onze thesis is zoals elke systematic review een werk van 2 onderzoekers. Het samenwerken met mijn thesispartner Karen Dilissen heb ik als heel vlot ervaren. We zaten op dezelfde golflengte qua aanpak en tempo. De communicatie verliep efficiënt. Gezien Karen en ik in verschillende provincies wonen (Leuven en Antwerpen), hebben we gretig gebruik gemaakt van online tools. We gebruikten een gedeeld online programma om onze artikels te screenen, waarin we initieel de beslissingen van de ander niet zagen maar wel diens voortgang konden opvolgen. Nadien, na het opheffen van de 'blind modus', konden we elkaars beslissingen wel zien zodat we samen de conflicterende artikels konden bespreken. Bij het verwerken van de informatie en het schrijven van de tekst werkten we in gedeelde documenten, hielden een gezamenlijke to-do lijst bij, stelden op deze manier vragen aan elkaar enzovoort. We zagen elkaar om de paar weken, en naarmate de tijd vorderde meermaals per week, via een online meeting om grotere zaken te bespreken en vragen/problemen samen op te lossen. Ook de regelmatige afspraken met onze co-promotor verliepen digitaal. Het feit dat onze thesis tot stand is gekomen zonder elkaar 1 keer in persoon te zien, onderstreept voor mijn enorm de kracht van digitaal werken. Ikzelf heb dit proces als heel positief ervaren, omdat er anders veel kostbare tijd verloren zou zijn gegaan aan transport. Maar ook de drempel om af te spreken zou veel groter zijn wanneer de afspraken fysiek zouden moeten doorgaan, wat het proces niet bevordert. Deze manier van werken is in de huidige maatschappij van grote meerwaarde.

Wat ik meeneem naar de praktijk vanuit dit onderzoek:

- Fijnstof is een onzichtbare vorm van vervuiling die zijn impact heeft op gezondheid. Reden te meer om patiënten aan te moedigen om op regelmatige basis het groen op te zoeken, zeker wanneer zij in een specifieke situatie bevinden zoals tijdens een zwangerschap of bij mentale problemen.
- Op beleidsniveau moet er meer aandacht komen voor milieu-invloeden op gezondheid. Wij zijn als huisarts een goed geplaatste persoon om hier de aandacht op te vestigen. Misschien dat ik hier op termijn wel iets mee wil doen.
- Het werken met twee aan 1 gezamenlijk project was een goede oefening in communiceren en samenwerken. De taken moeten verdeeld worden, er moeten duidelijke afspraken gemaakt worden en ieder moet zijn verantwoordelijkheid nemen. Hierin moet een goed evenwicht bewaard worden, maar dat liep eigenlijk vrij vanzelfspreken tussen ons. Het was ook een goede oefening in het overbrengen van opmerkingen of commentaar op een constructieve en respectvolle wijze. Ook dit is zeer vlot verlopen naar mijn aanvoelen.
- Digitaal vergaderen onder collega's kan zeer efficiënt verlopen en biedt een grote meerwaarde op vlak van tijdsbesteding en work-life balance. M.i. is dit voordeel wel beperkt tot kleinere groepen van enkele personen, want zodra de groep groter wordt leert de ervaring dat een digitale sessie toch niet zeer efficiënt verloopt. Ik wil hierbij ook benadrukken dat ik met deze stelling wel degelijk doel op intercollegiale overlegmomenten en niet op niveau van consultaties met de patiënt. Hierbij vind ik het face-to-face contact net enorm belangrijk om een band te scheppen, de afstand te verkleinen, kortom het menselijk contact te behouden. Wanneer men dit op systematische wijze zou digitaliseren denk ik dat er veel nuance verloren zou gaan ten koste van de toch wel unieke vertrouwensrelatie tussen patiënt en huisarts.