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Food insecurity, dietary quality and health in the Netherlands

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CHAPTER 7

General discussion

The main objective of this thesis was to improve understanding of the prevalence of food insecurity in the Netherlands and its consequences for dietary quality and health. In this chapter, we first describe and discuss the main findings presented in this thesis. Secondly, we discuss methodological considerations regarding the study design and assessment of variables. Thirdly, the implications of our research, as well as directions for future research, are discussed. Finally, an overall conclusion is presented.

Main findings

While food insecurity has previously been shown to be associated with obesity, the explanatory factors underlying this association are less clear. The study presented in **Chapter 2** therefore explored potential explanatory factors by conducting mediation analyses, which involved describing the association between food insecurity and obesity and potential mediation by sociodemographic and lifestyle factors. The findings indicated that food insecurity was associated with obesity but not with overweight, and that the food insecurity-obesity association was partially mediated by living situation, dietary quality, and smoking status. Our finding that food insecurity and obesity were associated among adults is consistent with previous literature; a systematic review and meta-analysis by Moradi et al. (2019), and a review by Te Vazquez et al. (2021), including the most recent studies on this topic, both indicate that food insecurity increases the risk of obesity, especially among women (1, 2). The mechanisms and pathways underlying this association are, however, not yet fully understood (3). **Chapter 2** advances our understanding of explanatory factors underlying the complex association between food insecurity and obesity, and as such contribute to filling one of the main research gaps in current literature on this topic: understanding the mechanisms and pathways underlying the association between food insecurity and obesity (3).

Improving health among disadvantaged groups and an ability to identify those most at risk of poor health has great potential for improving population health. Population health management is an emerging concept that aims to improve population health and includes effective risk stratification: identification of populations that are most at risk of poor health (4). Risk stratification and explaining poor health based on traditional risk factors and social determinants of health (such as employment status, educational level, and income) often yields disappointing results, indicating

that less traditional social determinants of health, such as food insecurity, might be worth considering for these purposes. In **Chapter 3** we therefore explored the value of assessing food insecurity and adding this to traditional social determinants of health when explaining poor physical and mental health: food insecurity was indeed a strong predictor of poor physical and mental health. Our results further indicated that food insecurity was of added value beyond traditional socioeconomic risk factors (i.e., age, educational level, income, living situation, employment, migration background): explained variance improved by approximately one-half for physical health and doubled for mental health. Although the association between food insecurity and poor health is well established in literature (e.g., (2, 5, 6)), our study nevertheless is among the first to investigate the added value of food insecurity status in explaining poor health. This information can contribute to effective risk stratification (by identifying populations at increased risk of poor health); to providing targeted interventions to improve their health; and to decreasing health care costs and utilization. Implementation requires information on food insecurity status to be available (for example through routine screening for food insecurity status, which is not current practice in the Netherlands) and the availability of effective interventions to reduce food insecurity and improve health. The importance of addressing social determinants of health when seeking to identify people at increased risk of poor health, which requires screening for these determinants, is recognized in recent literature (7-9). However, screening for social determinants such as food insecurity does require consideration of the health benefits, health care costs, and acceptance of screening by both the person being screened and the professional performing the screening. Furthermore, despite a growing recognition of the importance of interventions aimed at reducing food insecurity and improving health outcomes, current literature provides little high-quality research on this topic (10). A recent review indicates that health care-based food insecurity interventions (based on food-related resources or assistance provided, and on providing food or food vouchers in addition to resource referrals) may improve food security and health outcomes, but more research is warranted (10).

Advancing our understanding of factors that influence eating behavior among people at risk of experiencing food insecurity is essential when developing targeted interventions to support this population. **Chapter 4** presents narratives of people at risk of experiencing food insecurity, using a qualitative approach to gain a better

understanding of the needs and perceptions regarding healthy eating behavior among this target group. The results of this study suggested that participants possess adequate nutritional knowledge; nevertheless, participants reported various social, environmental and financial barriers to healthy eating behavior, including poor mental health, financial stress, high food prices, and an unfavorable food environment. This chapter offers some initial suggestions for interventions that may help improve eating behavior in this vulnerable population. These suggestions include lowering the price of healthy foods and improving the food environment, as high prices of healthy foods and an unfavorable food environment characterized by an abundance of fast-food outlets were among the main perceived barriers for healthy eating articulated by our participants. This is in line with a recent photovoice study by Lindow et al. (2021) on how food insecurity affected parent's eating behavior and health. This study described how healthy foods seem out of reach due to relatively high prices, whereas unhealthy foods are relatively cheap, heavily promoted and food environments contain an abundance of unfavorable food outlets, all of which represent barriers to healthy eating (11).

In **Chapter 5**, we further explored the influence of the food environment as a barrier for healthy eating among people at risk of experiencing food insecurity. In this study, we assessed the interplay between fast-food outlet exposure, household food insecurity, and dietary quality in disadvantaged districts in the Netherlands. Fast-food outlet exposure measures were calculated using Geographical Information Systems (GIS). The results of the study presented in **Chapter 5** indicated that experiencing food insecurity was associated with lower dietary quality, and that this association was moderated by fast-food outlet proximity: stratified results revealed that the adverse effect of food insecurity on dietary quality was more pronounced for those with the nearest fast-food outlet located closer to home. This is in line with previous literature, showing substantial evidence for an association between experiencing food insecurity and lower dietary quality (12). Contrary to these studies, a recent study by Gupta and Freedman (2021) did not show a significant direct association between food insecurity and dietary quality, however, their results indicated that among people experiencing food insecurity, a greater perception of healthy food availability was associated with a better dietary quality (13). These authors argue that people experiencing food insecurity may be more constrained to the retail food choices available within their neighborhood because of limited access to transportation (13). The results of the study presented in **Chapter 5** also showed that increasing fast-

food outlet distance (i.e., increasing distance between the fast-food outlet and the participants' home) was associated with a slightly higher dietary quality (indicating that maintaining a healthy diet may be easier when living further away from a fast-food outlet), whereas no association was found between fast-food outlet density and dietary quality. A recent study including over 8000 Dutch older adults also found no evidence for an association between an unhealthy food environment with a relatively high proportion of fast-food outlets and lower dietary quality (14). Overall, the evidence for an association between the food environment and dietary quality remains limited and shows inconsistent results (15). Our study contributes to the growing body of literature focused on the influence of the neighborhood fast-food environment on food insecurity and dietary quality. Taken together, this indicates that improving dietary quality by promoting healthier food environments may be especially important in areas with high percentages of food insecure households, as people experiencing food insecurity are most affected by their food environment, and because food insecurity and a high prevalence of fast-food outlets generally cluster within neighborhoods (16, 17).

The role of financial barriers in explaining dietary quality is elaborated on in **Chapter 6**. In this study, we aimed to assess whether extending the Theory of Planned Behavior (TPB) - one of the most commonly used models for understanding health behaviors such as dietary behavior – by adding barriers related to financial scarcity and food insecurity better explains dietary quality. Our findings indicate that compared to the traditional TPB and less extended TPB models, the most extended TPB (including both financial scarcity and food insecurity) showed best model fit and best explained variance in dietary quality, highlighting the importance of taking finance-related barriers for healthy eating into account when seeking a better understanding of individual dietary behaviors in populations with a lower socioeconomic position. As the literature on psychosocial factors explaining differences in dietary intake is still relatively sparse, our study represents a substantial contribution to addressing this gap in current research (18). A recent study by Ranjit et al. (2021) showed that levels of various behavioral and psychosocial mediators of dietary quality, such as self-efficacy for healthy eating, were low among people experiencing food insecurity, and that psychosocial factors (e.g., self-efficacy for healthy eating and for planning healthy meals, stage of change of fruit and vegetable consumption) appeared most effective in reducing inequalities in dietary quality (18). Although including other psychosocial factors than used in our study (i.e., self-efficacy and stage of change),

this study also stresses the importance of addressing psychosocial factors as well as systemic factors linked to food security (e.g., costs, availability, and accessibility of adequate food) when seeking to improve dietary quality in low-income populations (18).

Methodological considerations and recommendations for future research

In the following sections, methodological considerations and strengths and limitations of the study designs and assessment methods applied in this thesis are discussed, as well as opportunities for future research.

Study design

Most studies presented in this thesis used a cross-sectional, observational study design. This study design was suited to the main aim of this thesis (which was to improve understanding of the prevalence of food insecurity in the Netherlands and its consequences for dietary quality and health) and was a pragmatic choice in view of the time and budget available for our studies. Nonetheless, to put the results of this thesis into perspective, this type of study design has several limitations that should be addressed. First of all, using cross-sectional data precludes conclusions on the temporal order of the associations and paths found in our studies, as the determinants and outcomes are simultaneously assessed (19). This is especially important for the mediation and path analyses presented in this thesis, as for these types of analyses we clearly assumed a temporal order. For example, in **Chapter 2** we assumed that food insecurity preceded mediating variables, which in turn preceded obesity. We further assumed that TPB constructs, financial scarcity and food insecurity preceded dietary quality in **Chapter 6**. For the studies presented in **Chapters 3** and **5**, we assumed that the determinants preceded the outcomes of the regression analyses, although this cannot be confirmed using a cross-sectional study design. However, our aim was not to establish causal pathways, but rather to gain a better understanding of how food insecurity, dietary quality, obesity, and other factors may be associated, and which could be potential factors to take into account when developing interventions. Nevertheless, a longitudinal study design assessing outcomes of interest at a later timepoint than determinants would allow the temporal order of pathways to be determined. Furthermore, a life course perspective is preferred for future studies, as life course theory (which states that what happens

at one moment in life influences what happens later in life) helps to explain the long-lasting adverse effects of experienced food insecurity (20). Experience of food insecurity is also closely linked to Adverse Childhood Experiences (ACEs) (a concept that, amongst others, encompasses experiences of physical and emotional abuse, neglect, and household instability, for example witnessing domestic violence or experiencing parental separation), and accumulating ACEs in childhood are linked to food insecurity later in life (21, 22). This highlights the importance of a life course approach for future studies seeking to understand and alleviate food insecurity.

Other challenges of observational, cross-sectional research are precision (i.e., a lack of random error or variation in the study estimates) and validity (i.e., a lack of systematic error) (19). In observational studies, random variation arises from the participant sample (as this is always limited to a selection of the possible sample that could have been included) and assessment of variables, which can affect the precision of the study estimates. Greater precision can be achieved by having balanced groups (i.e., people with and without food insecurity), and including a sufficiently large sample, as we have strived to do in our studies. As for validity, one can differentiate between internal validity (i.e., the strength of the inferences from the study: differences in outcome arise from differences in exposure rather than from systematic errors) and external validity (i.e., generalizability of the results to a more universal population) (19). In our studies, we attempted to limit systematic errors and biases, and to include representative study populations. However, it should be noted that for the studies presented in **Chapters 2, 3, and 5**, our sample size was relatively small and mainly included women living in a disadvantaged urban setting, even though we recruited participants at various locations and also offered help with filling in the questionnaires (which were available in different languages), both of which increased our reach within the target population. The study presented in **Chapter 6** managed to include a relatively large sample size, although it should be noted that questionnaires were only available in the Dutch language and no help could be offered with filling in the questionnaires due to the anonymous online format. This approach excluded non-Dutch speaking and illiterate people, which may explain the disproportionately high number of participants born in the Netherlands in this study. Therefore, to demonstrate external validity of our results and generalizability to the broader Dutch population, future studies should replicate our findings in different populations, places, and time periods. Furthermore, it is important that future studies approach the problem from a life course perspective

and consider specific subgroups separately, as risk of experiencing food insecurity varies between and within countries, regions, populations, and life stages.

Assessment of study variables

Assessment of food insecurity status

Food insecurity is an elusive and multidimensional concept, occurring when people lack consistent physical, social, or economic access to adequate food due to limited resources. Naturally, this makes food insecurity status difficult to define (as described in **Chapter 1**) and even more difficult to measure (23). Various indicators, assessment procedures and surveys are available and are used to estimate food insecurity. National-level food insecurity estimates include the Global Hunger Index (GHI) and Global Food Security Index (GFSI) (24). To assess experience-based food insecurity (i.e., indicators that “directly measure food insecurity based on the food deprivation process that food insecurity households experience”) as carried out in our studies, a range of surveys are available including the United States Department of Agriculture Food Security Survey Modules (USDA FSSM), Household Food Insecurity Access Scale, Household Hunger Scale, Latin American and Caribbean Household Food Security Scale, and Food Insecurity Experience Scale (24).

In our studies we used the USDA FSSMs, which are widely used and accepted and have shown excellent predictive validity and good fit (24). For the majority of studies presented in this thesis, we used the most comprehensive (18-item) USDA FSSM, but in the study presented in **Chapter 6**, due to the already extensive questionnaires developed for that study, we chose to use the 6-item module in order to limit participant burden. Although the original USDA FSSM was only validated for use in the United States, the module has been extensively adapted and subsequently validated among various populations and settings in recent years (24). Although it has been previously used in the Netherlands (25), it should be noted that the USDA FSSM has not yet been validated specifically for the Dutch population. This indicates the need for a future Dutch validation study to assess whether the (translated) USDA FSSM is actually suitable for assessing food insecurity in the Dutch context and sufficiently covers all dimensions of food insecurity that may occur in the Netherlands.

Regardless of which specific survey is used, and although tools to measure experience-based food insecurity have been shown to provide a reliable and valid estimate of food insecurity (26), several biases associated with these tools need to be addressed.

Firstly, these tools are generally self-reported. As opposed to objective measures of nutritional status (such as anthropometric measures) or stress (such as chronic stress levels measured in hair cortisol), self-reported experience-based food insecurity tools reflect a subjective experience/perception of inadequate access to food. Different groups (for example, people of different gender, ethnic- or cultural background) may perceive and report their food insecurity experience differently (26). Furthermore, household food insecurity is often reported by one member of the household and their responses may not reflect the views of other family members. Child food insecurity status is often reported by a parent, while parents may not be reliable reporters of their children's intakes and experiences (27, 28).

Secondly, self-reported measures of food insecurity and other variables used in our studies may have been affected by biases such as social desirability bias and recall bias. For example, we used reference periods of up to 12 months for experienced food insecurity, which may have been difficult to recall in general or recall may have been affected by current food security status. It is important here to distinguish between non-differential and differential misclassification: non-differential misclassification occurs when the probability of individuals being misclassified is equal across all groups in the study, whereas differential misclassification occurs when the probability of individuals being misclassified varies between groups because the error depends on other variables (29). With regard to measurement of food insecurity, differential misclassification may have occurred if participants currently experiencing food insecurity show differences in their recall and reporting of factors such as dietary intake, financial scarcity, and psychosocial factors related to healthy eating (such as attitudes, subjective norm, perceived behavioral control, and intention) compared to food-secure people. This is not unlikely, as people currently struggling to gain adequate access to food may be more focused on food and finance-related matters, which may result in differences in reporting of these matters. As these differences may theoretically lead to biased results, replication of the study using repeated measures of food insecurity and related variables across various time points is therefore needed.

Assessment of dietary quality

As most studies described in this thesis included dietary quality (as a determinant, mediator, or outcome), it is important to address some methodological considerations regarding the assessment of dietary intake and dietary quality. To assess dietary

intake and compute dietary quality scores in our studies, we used short Food Frequency Questionnaires (FFQ) that contained only a limited range of foods. The FFQ did not allow detailed assessment of nutrient intakes and therefore our dietary quality scores could not be validated by relating them to nutrient adequacy (30). Based on previous literature describing a similar FFQ, we believe that these FFQs adequately provided an approximate ranking of subjects according to their dietary quality (31). An important consideration is that the FFQ was designed for - and therefore most applicable to - Dutch eating patterns and to a lesser extent to non-Dutch eating patterns. It should further be noted that we based our dietary quality scores on Dutch dietary guidelines, which may also be less suitable for non-Dutch ethnic groups. This could have biased our results, for example if particular foods that are more often eaten by non-Dutch ethnic groups were not included in the FFQ and therefore not considered in the dietary quality score. Depending on the healthiness of these foods, this could have resulted in both higher or lower dietary quality scores among various non-Dutch ethnic groups. Therefore, future studies should assess the appropriateness and potential need for improvement of the FFQ for non-Dutch ethnic groups. Furthermore, dietary intake was self-reported, and may therefore have been affected by biases such as social desirability bias and recall bias as described above. It would be valuable if future studies combine dietary intake as assessed using the FFQ with objective measures of dietary quality and nutrient intake such as biomarkers for vitamins and minerals obtained from urine or blood.

Assessment of the food environment

Several methodological considerations regarding food environment research have already been discussed in **Chapter 5**. Following the methodological considerations regarding the assessment of dietary intake described above, it should be noted here that it would have been valuable to obtain information on actual fast-food purchase and consumption behaviors from the participants, rather than just assess density and proximity of fast-food outlets and an indication of overall dietary quality.

Lamb et al. (2020) indicate that longitudinal studies or quasi- or natural-experimental designs (with appropriate comparison groups), including information on neighborhood choice and preference and related individual characteristics, offer the best potential to study how changes in the environment influence changes in behavior (32). As described in a systematic umbrella literature review by Sawyer et al. (2021), the food environment includes social, physical, economic, and political

factors within the dimensions of food availability, affordability, accessibility and acceptability (33), which are also essential elements of food security. They note that despite observed associations between adverse food environments and poor diets, unravelling the mechanisms underlying these associations in low-income groups remains difficult. A novel, comprehensive and promising way to study the associations between food environments, dietary intake, and poverty is from a systems dynamics perspective (33). These authors applied causal loop diagramming (a specific method within system dynamics research), resulting in an evidence-based mapping of the complex adaptive system underlying the food environment influencing dietary intake in low-income groups. This showed that an adverse food environment is shaped by multiple, interconnected feedback loops - wherein food insecurity also plays an important role - increasing accessibility, availability, affordability, and acceptability of unhealthy foods, leading to poorer dietary intake in low-income groups (33). The comprehensive and complex systems described in this study help to put our findings into perspective and highlight the importance of taking broader systems into account when seeking to identify leverage points on which interventions are more likely to have sustainable impact in terms of accessibility, availability, affordability, or acceptability of healthier food (33).

Implications and future directions

As outlined throughout this thesis, even in high-income countries such as the Netherlands, food insecurity exists and negatively impacts dietary quality and health. Food insecurity is further associated with increased healthcare utilization and costs, even when socioeconomic factors are taken into account (34). These factors make food insecurity an important issue for population health and highlight the pressing need to properly address food insecurity and its consequences. The question is, how should we address this problem? Should we screen for food insecurity in the Netherlands? And once we have identified people at increased risk of food insecurity, how can we help them to improve their dietary quality and health? These questions will be addressed below.

Should we screen for food insecurity in the Netherlands?

A growing body of literature recognizes that addressing social determinants of health is essential when seeking to improve population health and identify people at increased risk of poor health (7, 8). Assessing and addressing social determinants

of health will require screening for these determinants, and is increasingly being recognized as a priority among interprofessional health care teams across various settings and domains (9). Only when health care providers are aware of the existence of social risk factors such as food insecurity, can they address these issues and improve access to resources, if available (9).

However, despite the recognized importance, at present neither food insecurity screening nor monitoring is routinely implemented in European countries, including the Netherlands. Indirect indicators of food insecurity, such as poverty or neighborhood-level disadvantage, are not suitable for accurately capturing perceived food insecurity. Food insecurity should therefore be assessed directly at the person or household level (9). Multiple tools are currently available for this purpose, ranging from very short, one-item screening tools to more elaborate surveys (9).

In the Netherlands, monitoring could be carried out at the population level, for example through inclusion in the CBS Health Survey (a yearly survey) or the GGD Health Monitor (a 4-yearly survey), both of which focus on health- and lifestyle-related topics among the Dutch population. This could provide insight into the prevalence and fluctuations over time of food insecurity, as well as risk groups/risk regions in the Netherlands and consequences for health, all of which could help guide policy making.

Alternatively, screening could also focus on specific (high-risk) populations, for example in nonclinical settings such as community centers (focusing on people living in disadvantaged contexts). Screening could also take place in clinical settings, for example at the general practice, as most Dutch citizens regularly visit their primary care physician. In order to minimize additional time and costs for health care providers and maintain acceptability of patients and providers, short screening tools are, unsurprisingly, best suited to health care settings (7). Furthermore, screening for food insecurity should not be done in isolation: screening results should be carefully discussed and interpreted within the prior context of the patient (9). Screening could also further reinforce stereotypes and stigmatization if only targeted subgroups are included in the screening, but this can be avoided by engaging the entire practice population (35, 36).

If screening for food insecurity is to be implemented in the Netherlands, it is important to monitor acceptability and address potential barriers for both those

screened and those doing the screening. For example, addressing this sensitive issue could be uncomfortable for both those questioned and those asking the questions (35). Efforts should also be made to minimize the reinforcement of stereotypes and stigmatization due to screening, indicating that best practices when screening for food insecurity in the Netherlands should be carefully explored.

Importantly, the identification of people at risk of food insecurity should ideally be followed by referral to effective interventions or resources. This may also call for referral to resources across domains, such as the social domain (i.e., social prescribing), which in the current Dutch context is challenging due to different funding streams. Moreover, in the absence of adequate interventions or resources, screening for food insecurity could be considered unethical (35), as also addressed in other criteria for screening programs for health outcomes (37, 38).

How can we help people experiencing food insecurity?

Due to the many determinants and multidimensional nature of perceived food insecurity, no single intervention or solution can be expected to resolve this issue. Regarding possible interventions, one can distinguish between population-based approaches (targeting the whole population with the aim of favorably shifting the entire risk distribution) and high-risk approaches (targeting specific, high-risk populations with the aim of decreasing the number of people at the high-risk end of the distribution), as emphasized by the epidemiologist Geoffrey Rose (39).

The importance of addressing food insecurity is increasingly being recognized in current literature: several literature reviews have appeared recently describing interventions to address food insecurity in high-income countries (10, 40-42). However, these reviews did not yield conclusive results regarding the most effective interventions for tackling food insecurity, as few high-quality studies or evaluations are currently available. Nevertheless, the findings of these reviews generally point towards systemic, population-based ‘upstream’ interventions (e.g., social protection programs; policy, governance and legislation targeting determinants related to living and working conditions; or community strengthening and building social support and cohesion) as the most promising approaches to structurally address food insecurity, although interventions with a ‘downstream’, individual focus (e.g., providing emergency food aid such as foodbanks or changing people’s food knowledge, skills or behavior) can also contribute to reducing food insecurity (10, 40-42).

As described by Geoffrey Rose, population-based interventions generally have the largest total effect (e.g., on reducing population-wide food insecurity prevalence, because the number of people at low/ intermediate risk is largest), but may offer little benefit at the individual level (e.g., the extent to which food insecurity is reduced in individual cases) (39). Therefore, one can argue that population-based and (high-risk) individual-based interventions are both needed when aiming to reduce food insecurity, and may indeed complement each other.

In the Netherlands, few interventions (either at population or individual level) are currently available to address food insecurity-related issues, and the available interventions have received little evaluation concerning their effectiveness in reducing experienced food insecurity.

However, the results of our own studies and conversations with participants yielded several suggestions for interventions. For example, although foodbanks can play an important role in alleviating acute food deprivation, they generally have a limited ability to improve overall food insecurity, for example due to inadequate amounts of nutritionally-dense foods (43). Our results and other literature suggest that an improved type of foodbank (e.g., providing more fresh and healthy foods) or an adapted form of food aid (e.g., a social supermarket and improved facilities for social contact) may better meet the needs and preferences of people experiencing food insecurity and should therefore be explored further (25, 44-46).

Our results and other literature further suggest that improving social networks and social support - included in social capital - among people (at risk of) experiencing food insecurity may be a promising strategy to reduce food insecurity and improve dietary quality and health (44, 47). For example, some of our participants perceived a lack of social support and social contacts in the neighborhood as barriers to healthy eating (44). To date, few studies have focused on intervention studies for social capital and health, and future research is warranted to improve our understanding on how social capital interventions can improve health (48). Evidence supporting interventions in the social environment (i.e., social norms and social support) to improve dietary intake is presently limited, but seems promising (49).

Another intervention proposed by our participants was to decrease prices of healthy foods and/or to increase prices of unhealthy foods (44, 45). Previous studies show that pricing interventions (such as taxes on unhealthy foods, subsidies on healthy

foods, and food subsidy programs for low-income families) can effectively improve dietary quality (50-52).

The results of our studies further highlight the need to promote healthier food environments when aiming to improve dietary quality among people experiencing food insecurity, for example by decreasing the number of unhealthy food outlets (such as fast-food restaurants), increasing the number of healthy food outlets, and a larger supply of healthy and affordable foods in supermarkets and restaurants (44, 45, 53). Although there is still considerable scope for research on food environment interventions, current evidence suggests a positive effect of these types of interventions on diet-related outcomes (54). This indicates that implementing and testing interventions to improve the food environment, and thus to improve dietary quality among people experiencing food insecurity, is well worth pursuing.

Through policy and legislation, the Dutch government plays an important role in creating an affordable and healthy food environment. Nevertheless, a recently published research report showed that the Dutch government is missing opportunities in this area and the study provided recommendations for policy improvements that are mostly in line with suggested interventions following from our studies (e.g., lowering prices of healthy foods; increasing prices of unhealthy foods; increasing the amount of healthy products in supermarkets, restaurants and other providers; and funding food assistance such as vouchers for free purchases of healthy foods for people living on a low income) (55). We naturally support these recommendations and believe they can also help improve the diets of people experiencing food insecurity. How these policy actions can best be implemented, however, remains to be determined, as current national and international laws and regulations hinder policy to lower prices of healthy foods (such as lower tax rates for fruits and vegetables) or improve the food environment (such as providing municipalities with the opportunity to ban unhealthy food outlets such as fast-food restaurants from (parts of their) community), although these possibilities are currently being explored (56). A recent study assessing the views of Dutch stakeholders regarding taxation of sugar-sweetened beverages, together with perceived barriers and facilitators to its adoption in the Netherlands, indicated that successful adoption of this tax will require several remaining challenges to be overcome: these barriers included the strong lobby against the tax, perceived public opposition, administrative load and difficulties in defining sugar-sweetened beverages (57).

In summary, reducing food insecurity and improving dietary quality and health in the Netherlands will require a range of population- and individual-based interventions. Further studies will be needed to assess the feasibility and effectiveness of these interventions in The Netherlands.

Population health management: pursuing the Triple Aim

The association between food insecurity and poor health is well established in literature (e.g., (2, 5, 6)). Moreover, food insecurity is associated with higher healthcare costs and more frequent emergency department visits and inpatient admissions (34). Food insecurity is forecasted to increase due to the current COVID-19 pandemic, thereby further increasing the risk of poor health in the short-term and long-term through several pathways, including household stress, behavioral-, and inflammatory pathways (58). Population health management is increasingly being recognized as a key concept to achieve improved population health, improved experienced quality of care, improved provider experience, and reduced healthcare costs (referred to as the Quadruple Aim) (59). The importance of screening for food insecurity and other social determinants of health and then integrating interventions to address these determinants in health care settings, as well as connecting patients to appropriate resources (such as local social support resources), is increasingly recognized and appears effective in improving poor health outcomes in adults in the United States (34, 60).

Based on evidence from the studies presented in this thesis, we advocate the development and implementation of population-based and risk group-based interventions that address food insecurity and its consequences, while incorporating the needs and preferences of this population. Particularly in the case of risk group-based interventions, appropriate screening is required and optimal forms and feasibility should be explored in the Dutch context. Together, these actions are expected to contribute to the Quadruple Aim by improving experienced quality of care (as underlying needs associated with food insecurity and its consequences can be addressed), reducing healthcare costs (which will follow from reduced food insecurity prevalence and improved health and dietary quality), improved provider experience (as their needs and preferences are also considered, allowing them to better aid their patients in need), and ultimately improved population health (61).

Conclusion

Based on this thesis, we can conclude that a considerable number of people in the Netherlands experience food insecurity. The findings described in this thesis provide insight into the consequences: food insecurity is associated with obesity, poor physical and mental health, and poor dietary quality. Our results also illuminate the role of sociodemographic and lifestyle factors, psychosocial factors and the food environment in these associations. In addition, our findings offer a clearer understanding of the perceived needs, perceptions and barriers regarding healthy eating among people at risk of experiencing food insecurity, as well as suggesting potential interventions. This thesis has shown that the issue of food insecurity needs to be better recognized and addressed in the Netherlands, for example through the development and implementation of population-based and risk group-based interventions for which appropriate screening and targeted interventions should be further explored.

References

1. Moradi S, Mirzababaei A, Dadfarma A, Rezaei S, Mohammadi H, Jannat B, et al. Food insecurity and adult weight abnormality risk: a systematic review and meta-analysis. *European Journal of Nutrition*. 2019;58(1):45-61.
2. Te Vazquez J, Feng SN, Orr CJ, Berkowitz SA. Food Insecurity and Cardiometabolic Conditions: a Review of Recent Research. *Current nutrition reports*. 2021:1-12.
3. Brown AGM, Esposito LE, Fisher RA, Nicastrro HL, Tabor DC, Walker JR. Food insecurity and obesity: research gaps, opportunities, and challenges. *Transl Behav Med*. 2019;9(5):980-7.
4. Steenkamer BM, Drewes HW, Heijink R, Baan CA, Struijs JN. Defining Population Health Management: A Scoping Review of the Literature. *Population Health Management*. 2016;20(1):74-85.
5. Pourmotabbed A, Moradi S, Babaei A, Ghavami A, Mohammadi H, Jalili C, et al. Food insecurity and mental health: a systematic review and meta-analysis. *Public Health Nutrition*. 2020;23(10):1778-90.
6. Abdurahman AA, Chaka EE, Nedjat S, Dorosty AR, Majdzadeh R. The association of household food insecurity with the risk of type 2 diabetes mellitus in adults: a systematic review and meta-analysis. *European Journal of Nutrition*. 2019;58(4):1341-50.
7. De Marchis EH, Torres JM, Fichtenberg C, Gottlieb LM. Identifying Food Insecurity in Health Care Settings: A Systematic Scoping Review of the Evidence. *Fam Community Health*. 2019;42(1):20-9.
8. Predmore Z, Hatef E, Weiner JP. Integrating Social and Behavioral Determinants of Health into Population Health Analytics: A Conceptual Framework and Suggested Road Map. *Population Health Management*. 2019;22(6):488-94.
9. O'Brien KH. Social determinants of health: the how, who, and where screenings are occurring; a systematic review. *Soc Work Health Care*. 2019;58(8):719-45.
10. De Marchis EH, Torres JM, Benesch T, Fichtenberg C, Allen IE, Whitaker EM, et al. Interventions Addressing Food Insecurity in Health Care Settings: A Systematic Review. *Ann Fam Med*. 2019;17(5):436-47.
11. Lindow P, Yen IH, Xiao M, Leung CW. "You run out of hope:" An Exploration of Low-Income Parents' Experiences with Food Insecurity using Photovoice. *Public Health Nutrition*. 2021:1-21.
12. Leung CW, Epel ES, Ritchie LD, Crawford PB, Laraia BA. Food Insecurity Is Inversely Associated with Diet Quality of Lower-Income Adults. *Journal of the Academy of Nutrition and Dietetics*. 2014;114(12):1943-53.e2.
13. Gupta NR, Freedman DA. Food security moderates relationship between perceived food environment and diet quality among adults in communities with low access to healthy food retail. *Public Health Nutrition*. 2021;24(10):2975-86.
14. Harbers MC, Beulens JWJ, Boer JMA, Karssenbergh D, Mackenbach JD, Rutters F, et al. Residential exposure to fast-food restaurants and its association with diet quality, overweight and obesity in the Netherlands: a cross-sectional analysis in the EPIC-NL cohort. *Nutrition Journal*. 2021;20(1):56.

15. Stevenson AC, Brazeau A-S, Dasgupta K, Ross NA. Evidence synthesis-Neighbourhood retail food outlet access, diet and body mass index in Canada: a systematic review. *Health promotion and chronic disease prevention in Canada: research, policy and practice*. 2019;39(10):261.
16. Ramsey R, Giskes K, Turrell G, Gallegos D. Food insecurity among adults residing in disadvantaged urban areas: potential health and dietary consequences. *Public Health Nutr*. 2012;15(2):227-37.
17. Fleischhacker SE, Evenson KR, Rodriguez DA, Ammerman AS. A systematic review of fast food access studies. *Obes Rev*. 2011;12(5):e460-71.
18. Ranjit N, Macias S, Hoelscher D. Factors related to poor diet quality in food insecure populations. *Translational Behavioral Medicine*. 2021;10(6):1297-305.
19. Carlson MD, Morrison RS. Study design, precision, and validity in observational studies. *Journal of palliative medicine*. 2009;12(1):77-82.
20. Frongillo EA, Bernal J. Understanding the Coexistence of Food Insecurity and Obesity. *Current Pediatrics Reports*. 2014;2(4):284-90.
21. Jackson DB, Chilton M, Johnson KR, Vaughn MG. Adverse Childhood Experiences and Household Food Insecurity: Findings From the 2016 National Survey of Children's Health. *American Journal of Preventive Medicine*. 2019;57(5):667-74.
22. Testa A, Jackson DB. Adverse Childhood Experiences and Food Insecurity in Adulthood: Evidence From the National Longitudinal Study of Adolescent to Adult Health. *Journal of Adolescent Health*. 2020;67(2):218-24.
23. Barrett CB. Measuring Food Insecurity. *Science*. 2010;327(5967):825.
24. Pérez-Escamilla R, Gubert MB, Rogers B, Hromi-Fiedler A. Food security measurement and governance: Assessment of the usefulness of diverse food insecurity indicators for policy makers. *Global Food Security*. 2017;14:96-104.
25. Neter JE, Dijkstra SC, Nicolaou M, Visser M, Brouwer IA. The role of food parcel use on dietary intake: perception of Dutch food bank recipients - a focus group study. *Public Health Nutr*. 2020;23(9):1647-56.
26. Broussard NH. What explains gender differences in food insecurity? *Food Policy*. 2019;83:180-94.
27. Hanson KL, Connor LM. Food insecurity and dietary quality in US adults and children: a systematic review. *Am J Clin Nutr*. 2014;100(2):684-92.
28. Nord M, Hanson K. Adult caregiver reports of adolescents' food security do not agree well with adolescents' own reports. *Journal of Hunger & Environmental Nutrition*. 2012;7(4):363-80.
29. Spencer E, Mahtani K, Brassey J, Heneghan C. Misclassification bias. In *Catalogue Of Bias* 2018. 2018 [Available from: <https://catalogofbias.org/biases/misclassification-bias/>].
30. Waijers PMCM, Feskens EJM, Ocké MC. A critical review of predefined diet quality scores. *British Journal of Nutrition*. 2007;97(2):219-31.
31. van Lee L, Feskens EJ, Meijboom S, Hooft van Huysduynen EJ, van't Veer P, de Vries JH, et al. Evaluation of a screener to assess diet quality in the Netherlands. *Br J Nutr*. 2016;115(3):517-26.

32. Lamb KE, Thornton LE, King TL, Ball K, White SR, Bentley R, et al. Methods for accounting for neighbourhood self-selection in physical activity and dietary behaviour research: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*. 2020;17(1):45.
33. Sawyer ADM, van Lenthe F, Kamphuis CBM, Terragni L, Roos G, Poelman MP, et al. Dynamics of the complex food environment underlying dietary intake in low-income groups: a systems map of associations extracted from a systematic umbrella literature review. *International Journal of Behavioral Nutrition and Physical Activity*. 2021;18(1):96.
34. Berkowitz SA, Seligman HK, Meigs JB, Basu S. Food insecurity, healthcare utilization, and high cost: a longitudinal cohort study. *The American journal of managed care*. 2018;24(9):399.
35. Garg A, Boynton-Jarrett R, Dworkin PH. Avoiding the Unintended Consequences of Screening for Social Determinants of Health. *JAMA*. 2016;316(8):813-4.
36. Chung EK, Siegel BS, Garg A, Conroy K, Gross RS, Long DA, et al. Screening for Social Determinants of Health Among Children and Families Living in Poverty: A Guide for Clinicians. *Current Problems in Pediatric and Adolescent Health Care*. 2016;46(5):135-53.
37. Andermann A, Blancquaert I, Beauchamp S, Déry V. Revisiting Wilson and Jungner in the genomic age: a review of screening criteria over the past 40 years. *Bull World Health Organ*. 2008;86(4):317-9.
38. National Institute for Public Health and the Environment [RIVM]. Criteria for responsible screening [Criteria voor verantwoorde screening] 2018 [updated 2-11-2018. Available from: <https://www.rivm.nl/bevolkingsonderzoeken-en-screeningen/screening-theorie/criteria-voor-verantwoorde-screening>.
39. Rose G. Sick individuals and sick populations. *International Journal of Epidemiology*. 2001;30(3):427-32.
40. Yii V, Palermo C, Kleve S. Population-based interventions addressing food insecurity in Australia: A systematic scoping review. *Nutr Diet*. 2020;77(1):6-18.
41. Loopstra R. Interventions to address household food insecurity in high-income countries. *Proc Nutr Soc*. 2018;77(3):270-81.
42. Holley CE, Mason C. A Systematic Review of the Evaluation of Interventions to Tackle Children's Food Insecurity. *Curr Nutr Rep*. 2019;8(1):11-27.
43. Bazerghi C, McKay FH, Dunn M. The Role of Food Banks in Addressing Food Insecurity: A Systematic Review. *Journal of Community Health*. 2016;41(4):732-40.
44. van der Velde LA, Schuilenburg LA, Thirivikraman JK, Numans ME, Kiefte-de Jong JC. Needs and perceptions regarding healthy eating among people at risk of food insecurity: a qualitative analysis. *Int J Equity Health*. 2019;18(1):184.
45. van der Velde LA, Numans ME, Kiefte-de Jong JC. Veranderingen in ervaren voedselzekerheid en eetgedrag in Nederland sinds de COVID-19-uitbraak. TSG - Tijdschrift voor gezondheidswetenschappen. 2021.
46. Neter JE, Dijkstra SC, Visser M, Brouwer IA. Dutch food bank parcels do not meet nutritional guidelines for a healthy diet. *Br J Nutr*. 2016;116(3):526-33.
47. Martin KS, Rogers BL, Cook JT, Joseph HM. Social capital is associated with decreased risk of hunger. *Social Science & Medicine*. 2004;58(12):2645-54.

48. Villalonga-Olives E, Wind TR, Kawachi I. Social capital interventions in public health: A systematic review. *Social Science & Medicine*. 2018;212:203-18.
49. de Ridder D, Kroese F, Evers C, Adriaanse M, Gillebaart M. Healthy diet: Health impact, prevalence, correlates, and interventions. *Psychology & Health*. 2017;32(8):907-41.
50. Niebylski ML, Redburn KA, Duhaney T, Campbell NR. Healthy food subsidies and unhealthy food taxation: A systematic review of the evidence. *Nutrition*. 2015;31(6):787-95.
51. Gittelsohn J, Trude ACB, Kim H. Pricing Strategies to Encourage Availability, Purchase, and Consumption of Healthy Foods and Beverages: A Systematic Review. *Preventing chronic disease*. 2017;14:E107-E.
52. Thomson K, Hillier-Brown F, Todd A, McNamara C, Huijts T, Bambra C. The effects of public health policies on health inequalities in high-income countries: an umbrella review. *BMC Public Health*. 2018;18(1):869.
53. van der Velde LA, Zitman FM, Mackenbach JD, Numans ME, Kiefte-de Jong JC. The interplay between fast-food outlet exposure, household food insecurity and diet quality in disadvantaged districts. *Public Health Nutr*. 2020:1-9.
54. Mah CL, Luongo G, Hasdell R, Taylor NGA, Lo BK. A Systematic Review of the Effect of Retail Food Environment Interventions on Diet and Health with a Focus on the Enabling Role of Public Policies. *Current Nutrition Reports*. 2019;8(4):411-28.
55. Djojosoeparto SK, Kamphuis CB, Vandevijvere S, Poelman MP. The Healthy Food Environment Policy Index (Food-EPI): Nederland: Een beoordeling van rijksoverheidsbeleid met betrekking tot de voedselomgeving in Nederland en beleidsaanbevelingen voor het creëren van een gezonde voedselomgeving: Utrecht University; 2021.
56. van Kolfschooten H, Neerhof R, Nijboer A, de Ruijter A, Visser M. Legal tools for a healthy food environment in the city [Juridisch instrumentarium voor een gezonde voedselomgeving in de stad]. Amsterdam: University of Amsterdam; 2020.
57. Eykelenboom M, Djojosoeparto SK, van Stralen MM, Olthof MR, Renders CM, Poelman MP, et al. Stakeholder views on taxation of sugar-sweetened beverages and its adoption in the Netherlands. *Health Promotion International*. 2021.
58. Leddy AM, Weiser SD, Palar K, Seligman H. A conceptual model for understanding the rapid COVID-19–related increase in food insecurity and its impact on health and healthcare. *The American Journal of Clinical Nutrition*. 2020;112(5):1162-9.
59. Bodenheimer T, Sinsky C. From triple to quadruple aim: care of the patient requires care of the provider. *Annals of family medicine*. 2014;12(6):573-6.
60. Harrison C, Goldstein JN, Gbadebo A, Papas M. Validation of a 2-Item Food Insecurity Screen Among Adult General Medicine Outpatients. *Population Health Management*. 2020.
61. Berwick DM, Nolan TW, Whittington J. The triple aim: care, health, and cost. *Health affairs*. 2008;27(3):759-69.

