The association between proximity to urban green and mental health in Utrecht, the Netherlands

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Abstract

Urban green space is proven to have a positive effect on mental health by attention restoration and stress recovery. Living closer to urban green is associated with improved mental health and a lower chance of developing psychological disorders. Research, however, remains inconclusive on its underlying pathways. Therefore, it is necessary to further identify the underlying characteristics regarding the association between urban green and mental health. The aim of this study was thus to investigate the association between the proximity of urban green space and mental health, with a further understanding of the underlying pathways based on personal, environmental and social characteristics. A questionnaire was used to acquire self-reported data on personal wellbeing, resilience and mental illness in which 6.854 participants from Utrecht were analysed cross-sectionally. Proximity to urban green was analysed by a straight-line distance (<300m, 300-600m and 600-900m) from the residence to the nearest city park, using GIS. Mental health constructs were separately modelled with regression analysis. A statistically significant association was found between proximity to urban green and mental illness. This association was dependent on the environmental pathway in which noise nuisance, home ownership and appreciation for the dwelling were important factors. No significant associations were found between proximity to urban green and personal wellbeing or resilience. Policies that help in fighting mental illness by urban green should thus focus on environmental pathways before looking at other characteristics. People living close to urban green might benefit more from the effect urban green has via the environment, than via the personal or social characteristics.

Keywords: urban green space; proximity; mental health; environmental characteristics

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1. Introduction

The treatment of mental health disorders is one of the biggest costs in the Netherlands when it comes to health care expenditure. From the total of 100 billion euros in 2018, 6.64 billion went to mental health care, which is an increase of 2% compared to the previous year (CBS, 2020). The severity of this problem is reflected in the 20,4% of the Dutch population that is diagnosed with psychological symptoms, complaints or illnesses in 2015 (which is an 1,2% increase compared to 2016) (CBS, 2020). Lifetime prevalence of depression is for instance relatively high (19%) in the Netherlands (de Graaf et al., 2010). Mental health problems thus have substantial consequences for health systems, cause considerable economic losses and have a large impact on the quality of life.

The importance of this topic has prompted researchers to indicate what protective and risk factors are affecting mental health. Individual characteristics seem to have an influence in this association.

Consistent evidence shows that gender, age, relationship status, working status, income, ethnicity, education, traumatic experiences and genetics have an influence on different mental health aspects (Belsky et al., 2019; Ettema & Schekkerman, 2016; Helbich, 2018; Rosenfield & Smith, 2012; Van Dyck et al., 2015). These individual characteristics are however not the only influencers of mental health as it turned out that neighbourhood characteristics have a large share in this association (Galster, 2013; Jivraj et al., 2019; Van Ham et al., 2013). Recent studies indicate that social and physical aspects of the neighbourhood indeed affect mental health. On a social level, the neighbourhood has an influence on mental health via social cohesion or connections, norms of reciprocity, interpersonal trust, social identification, social safety and natural surveillance (P. Fong et al., 2019; Moore, S Kawachi, 2017; Van Dyck et al., 2015). Furthermore, the physical aspects of the neighbourhood can be divided into built and natural features. These physical aspects are suggested to have an influence on mental health via public safety, housing conditions, air and noise pollution, walkability, aesthetics, urbanicity and accessibility, and proximity to urban green (Groenewegen et al., 2018; Rocha et al., 2017; Van Dyck et al., 2015).

As findings suggest that this proximity of urban greenery to people's home play an important role in their mental health (de Vries, 2016; Sturm & Cohen, 2014; van den Bosch & Meyer-Lindenberg, 2019), this relatively easy and inexpensive tool became a topic receiving increased attention by policymakers and researchers (Gascon et al., 2015; Helbich, 2018). The underlying pathways have therefore been extensively studied. As many empirical studies have shown, these pathways can be divided into personal, environmental and social characteristics (Abraham et al., 2010; Carrus et al., 2015; Dzhambov, Markevych, Hartig, et al., 2018; Scopelliti et al., 2016). Personal pathways that are suggested to influence mental health via urban green are at least: the reduction of stress, improvement of mood and wellbeing, restoration from attentional fatigue and increase of happiness and life satisfaction (Beyer et al., 2014; Dzhambov, Markevych, Hartig, et al., 2018; Hartig et al., 2014; Pfeiffer & Cloutier, 2016; Triguero-Mas et al., 2017). These are seen as potential buffers to poor mental health (Rautio et al., 2018; M. van den Berg et al., 2015). Environmental pathways, influencing mental health via urban green, are the reduction of crime, improvement of air quality, attenuation of incoming noise, mitigating the heat island effect and encouragement of physical activity and exercise (Aram et al., 2019; Dzhambov & Dimitrova, 2015; Han et al., 2013; Klingberg et al., 2017; Kuo & Sullivan, 2001; M. M. van den Berg et al., 2019). Lastly, social pathways influencing mental health by urban green are at least: social cohesion, social networking and interaction, community quality of life, and positive feelings about the local residence in the neighbourhood (De Vries et al., 2013; Groenewegen et al., 2018; Helbich et al., 2020; Jennings & Bamkole, 2019; Kearney, 2006; Kuo, 1998; Jolanda Maas et al., 2009).

However, as important urban green seems to be for mental health, cross-sectional and longitudinal research on this association and its underlying pathways remain inconclusive (Boers et al., 2018; De

Vries et al., 2013; Houlden et al., 2018; Taylor et al., 2018). Associations were found for general and mental health and were consistent, over different distances from the residence, for several levels of socioeconomic status, urbanization and gender, however no associations were found in this study between green space and physical activity or social contacts (Triguero-Mas et al., 2015). Elsewhere was suggested that indeed streetscape greenery was associated with stress but also with social cohesion while no relationship was found for greenery and physical activity (De Vries et al., 2013). These findings are partly confirmed by other streetscape studies that found a mediating effect of stress, physical activity, air quality, noise and social cohesion (Wang, Helbich, et al., 2019). Other studies also found positive association between subjective residential proximity to green and residential surrounding, or visitation of greenness and mental health for all 3 pathway categories (Dadvand et al., 2016; Ettema & Schekkerman, 2016; Vujcic et al., 2019). According to another study that was in line with the findings on mental health, air quality and noise, the associations of social support and physical activity were minimal (Gascon et al., 2018). Others found different results in terms of the social pathway (Dzhambov, Markevych, Hartig, et al., 2018) while different studies emphasize that the social and personal pathways are more important and the effect of the physical neighbourhood is limited (Dong & Qin, 2017; Helbich et al., 2020). Another study stated the importance of only personal and environmental pathways (Pietilä et al., 2015). Older studies found contrary results and reported that only physical health status significantly contributed to the variance in self-rated health while emotional and social pathways had no effect (Ratner et al., 1998).

This lack of consensus might be the result of how the pathways are used and measured. Previous literature often focused on one or two pathways (Astell-Burt & Feng, 2019; Enssle & Kabisch, 2020; Ojala et al., 2019). This is for instance the case in the various articles that solely refer to personal and environmental pathways, by which urban green has its beneficial impact but entirely neglect any considerations of the social pathway (Akpinar et al., 2016; Coldwell & Evans, 2018; Tsai et al., 2018). Over-adjusted results thus ensure for an incomplete description of the association between urban green and mental health (Groenewegen et al., 2018; A. C.K. Lee & Maheswaran, 2011; Tavano Blessi et al., 2015). This might be partly resolved by adding the characteristics in a consecutive manner. The added value of each pathway can then be observed. The scarce literature that does however take into account the different pathways simultaneously, do this by summing up previous studies that focus on one of the pathways (Jennings et al., 2016; A. C.K. Lee & Maheswaran, 2011). This review-based research overlooks a possible interaction effect by solely summarizing previously found outcomes. Not only does this research design result in poor generalization, combining results of studies using varying methods to apply triangulation also ensue the lack of a uniform methodology (Oppermann, 2000; Polit & Beck, 2010). Furthermore, the interplay between the multiple pathways is often overlooked (Helbich et al., 2020). Personal, environmental and social characteristics might reinforce or equalize each other. Such coherent associations should be looked into (Triguero-Mas et al., 2015; Wang,

Helbich, et al., 2019). The gap that needs to be filled is thus not only the underrepresentation of research on the sequent association per pathway, but also the measurement of these pathways in a simultaneous way regarding several mental health aspects.

The aim of this study was thus to investigate the association between the proximity of urban green space and mental health with a further understanding of the underlying pathways based on personal, environmental and social characteristics. More insights will be given in the multiple aspects of mental health in terms of the dimensions of personal wellbeing, resilience and mental illness. The research question that was thus asked in this paper was: *What is the association between proximity to urban green space and mental health factors when considering personal, environmental and social characteristics?* Two hypotheses were developed including that there is a negative association between distance to urban green and self-reported mental health outcomes, and that this association is dependent on personal, environmental and social characteristics.

2. Materials and methods

2.1 Study area

This cross-sectional study was conducted in Utrecht (352.000 inhabitants), the Netherlands. Utrecht is the fastest growing city in the Netherlands with a relatively high population density (3,761 per km2) but low amounts of greenery per dwelling (113,3 m2 in comparison to 295 m2 of natural surface per inhabitant for the Netherlands). This urbanized landscape ensures that the current city parks are of great importance to the city and that the amounts and types of greenery outside of these parks are as homogenous as possible, making comparisons across the city more equivalent. These 23 city parks are located within an urbanized (mean population density of 5.243 per km2) environment, making Utrecht a suitable research area.

2.2 Study design and study population

The data that is used in this research originates from the Inwonersenquête 2019 (IE2019) survey, conducted by I&O of the municipality of Utrecht. In this version of the IE2019, 27.831 inhabitants were asked by letter to fill in this questionnaire, which could then be filled in online (via a link in the letter) or on paper (included in the letter). This sample was made on a response estimate based on the questionnaires from previous years. The mean percentage of response rates of IE2017 and IE2018 (combined) was calculated per neighbourhood. This percentage was then taken from the total amount of inhabitants (227.632) of the neighbourhoods which resulted in 27.831 letters. To make sure that the demographics of the participants were equally represented in these neighbourhoods, the sampling was based on 6 ethnicity categories and 12 age categories. The participants were then randomly selected from the BRP (Basisregistratie Personen), which contains personal data of residents of the Netherlands known to the municipality, after which a letter was sent to their home address. Inhabitants older than

the age of 16 and living in the municipality of Utrecht were contacted in the period of October and November of 2019. Inhabitants who indicated in previous years that they no longer wish to participate, and inhabitants who were included in the sample of the previous year, were excluded from this year's sample. Furthermore, the 70 respondents who died or relocated, were excluded and the 6 participants of which the BRP-data was unknown, were excluded resulting in a dataset of 6.854 participants. In this survey (administered in the Dutch language) questions were asked on subjects as; the city, the neighbourhood, social contacts, culture and sports, recreation and personal questions. Questions on other subjects were askes but not included in this study.

2.3 Data

Mental health as outcome variables

Mental health was measured with the use of 3 constructs. The first construct is personal wellbeing, consisting of 2 items. The statements that were included are; ''I am satisfied with my life'' and ''I am happy''. Both items are on a 5-point Likert scale ranging from ''strongly agree to ''strongly disagree''. The sum of both items forms a total measure, ranging from 2 to 10 in which a lower number represents a better personal wellbeing level. A good internal consistency across the items was assessed by the Cronbach's Alpha which was .845.

The second mental health construct is resilience including the questions ''Are you someone who continuous when things went wrong (when life was hard on you)'', ''Are you someone who manages in hard times?'' and ''Are you someone who arranges and organizes help yourself if necessary?''. All 3 items are on a 4-point Likert scale ranging from ''(almost) always'' to ''no''. These items form a total score ranging from 3 to 12 in which a lower number represents a higher resilience level. The Cronbach's Alpha of .751 represents an acceptable internal consistency for such a psychological construct (Peters, 2014).

Lastly, mental health is measured by the presence of a mental illness which was asked in the personal questions. The statement used to check the presence of such an illness was ''I have a psychiatric illness''. Participants could indicate whether they had a psychiatric illness by filling in a checkbox.

Proximity to urban green space

In this study all urban parks of Utrecht were included. This was done by retrieving all mentionable green spaces, within Utrecht, from the municipality as indicated on their website (Geemente Utrecht, 2020). This led to 53 areas which still included community gardens, allotments and courtyards which presumably tend to have different underlying mechanisms in the association between urban green and mental health (Francis, 1987). Visitors of these areas tend to have a different intension and experience in comparison to visitors of city parks, due to the place identity attached to these self-created gardens resulting in a sense of achievement and involvement in the physical space (Francis, 1987; Kingsley et al., 2009). After excluding these areas, the only 23 areas that were included, were categorized as city

parks by the municipality and were open to the public. All parks are located in a residential surrounding (with a mean population density of 5.243 per km2). Data on city parks were provided by the municipality of Utrecht (Information and Process management department). GIS was used to estimate the straight-line distance to the nearest park for the 6854 participants. This Euclidean distance is based on European guidelines, which states that this linear distance is reasonable because it replicates the different speeds of different age categories in society according to approximately 5 min walking distance along walkable roads or pathways (World Health Organization, 2016). Furthermore, Euclidean distance was used over street distance, because street distance neglects the consideration of human-oriented visibility of the environment (Yu et al., 2016). As research has shown that even non-visitors of urban green could experience the positive influence (presumably restorative) of urban green by living nearby, street networks becomes less relevant (Li & Sullivan, 2016; Nutsford et al., 2013). It is suggested that this is due to the visibility from the residence someone lives in (Markevych et al., 2017; van Herzele & de Vries, 2012; Yu et al., 2016). This would mean that participants living close to urban green which can be experienced from one's home, would be excluded when using street distance because it would for instance be obstructed by a river and thus cannot be reached in a short walk or drive while it does influence someone's mental health. In this study were proximity is important, Euclidean distance is thus preferred. The home addresses are on a postal code-6 level with an average size of 10.25ha (SD 81.92ha) with on average 26.4 participants in them. This Euclidean distance from the boundaries of the closest city park was divided into three ranges (radius of <300m, 300-600m, and 600-900m) from one's residential address. Similar distances were used elsewhere (Krellenberg et al., 2014; Schipperijn et al., 2010; Watts et al., 2013) and follow the European guidelines for proximity to parks (World Health Organization, 2017).

Covariates

Several socioeconomic and demographic characteristics used previously, were included (Dong & Qin, 2017; Wang, Helbich, et al., 2019). The covariates coming from the IE2019 that were included, are age, gender (men, women), ethnicity (Dutch, Western background, non-Western background), education (low, medium and high), net household income per month (grouped in 5 categories). Furthermore, several variables were included that described the environmental characteristics. These included whether someone lived in a unpleasant neighbourhood or not, satisfaction with greenery in the neighbourhood (parks, public gardens, estates) (very satisfied to very dissatisfied), satisfaction with the park in the neighbourhood (very satisfied to very dissatisfied), noise nuisance from traffic, companies or other noise (no (almost) never to yes often or sometimes), suffer from air pollution (often to (almost) never), and questions on the accommodation in which participants live. These included the type of dwelling (single-family house/multi-family house), owner-occupied home/rental home and report mark of the dwelling (1-10). Lastly, the density of the neighbourhood per square kilometre was included. This was calculated by the environmental address density which is the

number of addresses within a kilometre divided by the acreage of the circle. These addresses per square kilometre are then divided into 5 urbanity classes in which 1 is very strongly urban (2500 or more addresses/km2) and 5 is not urban (less than 500 addresses/km2). For the social characteristics, the following statements were submitted ‘’The people in this neighbourhood don’t know each other very well’’, ‘’The people in this neighbourhood treat each other in a pleasant way’’, ‘’I live in a sociable neighbourhood’’, ‘’The people in this neighbourhood interact a lot’’ and ‘’I feel comfortable with the people who live in this neighbourhood’’, which could all be answered with agree, neutral and disagree.

2.4 Analysis

Descriptive statistics were used to characterize the study participants’ demographic and socioeconomic features. Proximity was then classified within an ordinal variable in which all postal codes were divided into the <300m, 300-600m, and 600-900m categories. The 3 mental health constructs were separately modelled with regression analysis. Personal wellbeing and resilience were analysed using linear regression models to examine the association with proximity to urban green taking covariates into account. Mental illness was a binary variable, thus a logistic regression was appropriate. Four models were estimated per outcome variable. In the first unadjusted model, only the proximity to city parks was included. The second model was adjusted for personal characteristics. The third model was adjusted for personal and environmental characteristics. The last and fully adjusted model included the personal, environmental and social characteristics. The R^2 was used to assess a model’s fit. The significance level for all analyses was set at 0,05.

3. Results

3.1 Descriptive statistics

The mean age of the study population was 41.9 of which 50.9% were female. Participants were predominantly Dutch (65.9%), while 24% had a non-Western background and 10% had a Western background. A large proportion was higher educated (61.7%), while middle (19.1%) and lower (14.2%) educated were less represented. About 12.1% had a net household income of less than €1.150 a month, 19.7% had an income between €1.150 and €2.150, 20.7% had an income between €2.150 and €3.500 and 28% had an income over €3.500. The participants were on average satisfied with the greenery (65.1%) and park (69.9%) in their neighbourhood and experienced the neighbourhood in which they live as pleasant (89,8%). Most of the participants suffered from noise nuisance (often or sometimes) (79,7%) and 44,8% suffered often or sometimes from air pollution. The apartment/flat was the most common type of dwelling (46,5%) and 50,9% of the participants lived in an owner-occupied home while 47,4% lived in a rental home. The mean report mark was 7.5. Most of the participants lived in a strongly urbanised environment with more than 2.500 addresses/km2. The participants that

indicated that the people in their neighbourhood did not know each other very well consisted of 45,6%, indicated that the people in the neighbourhood treat each other in a pleasant way of 66,9%, indicated that they lived in a sociable neighbourhood of 56,6%, indicated that the neighbourhood interacted a lot of 23,3% and 60,4% indicated that they felt comfortable with the people that live in their neighbourhood. Furthermore, the mean of personal well-being was 3.86 (on a scale from 10 to 2), the mean resilience score was 4.8 (on a scale from 12 to 3) and 3.8% checked the box of having a mental illness. There were 225 missing values for personal wellbeing, 351 for resilience and 332 for mental illness. These cases were included in the regression analyses since they did not alter the outcomes.

3.2 Regression analysis

Table 1, 2 and 3 represent the regression analyses in which personal wellbeing, resilience and the presence of a mental illness was analysed. The first unadjusted model comprised only the proximity to urban green space in terms of buffer groups. The second unadjusted model included personal characteristics, the third unadjusted model included personal and environmental characteristics and the fully adjusted model included personal, environmental and social characteristics. The model fit improves more than expected by chance alone, when adding the different characteristics as indicated by the R^2. The adjusted R^2 for the models adjusted for personal characteristics were: .091 for personal wellbeing, .176 for resilience and .077 for mental illness. The adjusted R^2 for the models adjusted for environment were: .158 for personal wellbeing, .186 for resilience and .107 for mental illness. The adjusted R^2 for the fully adjusted models were: .180 for personal wellbeing, .194 for resilience and .109 for mental illness. In the last model significant likelihood ratio test values were found for all outcome variables ($p = .000$) except for mental illness ($p = .965$) on social characteristics.

Proximity

In table 1, the linear regression analysis of personal wellbeing is represented. The unadjusted and fully adjusted models showed no significant correlation between proximity and urban green space. In table 2, the linear regression analysis of resilience is represented. Again, no significant correlations were found between proximity and urban green space in the unadjusted and fully adjusted models. In table 3, the binary logistic regression analysis of mental illness is represented. The association between proximity and urban green space was significant in the unadjusted model including environmental characteristics. Participants living 300m to 600m from urban green, are more likely to have a mental illness than participants living within 300m from urban green space ($\beta = .304$, $p = .029$).

Personal wellbeing

Personal wellbeing was analysed in the first regression (table 1). The unadjusted model for personal characteristics showed some statistically significant variables. Age ($\beta = .007$, $p = .000$) and gender ($\beta = -.258$, $p = .000$) were significantly associated with personal wellbeing, meaning that older

participants experienced a slightly worse personal wellbeing and women experienced a better mental wellbeing. Furthermore, participants with a non-Western background experienced a worse personal wellbeing in comparison to Dutch participants (β = .227, p = .000), which was also found for the income group of €1150-€1600 relative to <€1150 (lowest group) (β = .180, p = .006). Participants with higher education experienced a higher personal wellbeing than participants with a low education (β = -.189, p = .000) which was also true for participants with an income of €2150-€3500 (β = -.218, p = .000) and >€3500 (β = -.666, p = .000) relative to the lowest income group.

Adding the environmental characteristics in the unadjusted model (table 1), did not alter most of the significance levels of the covariates and did slightly change the magnitude of the coefficients. The association of non-Western participants experiencing a worse personal wellbeing in comparison to Dutch participants, became insignificant. Furthermore, participants that labelled their neighbourhood as unpleasant relative to participants that labelled their neighbourhood as pleasant (β = .395, p = .000), participants that suffered from noise nuisance (β = .148, p = .000) and participants that lived in a strongly urban relative to very strongly urban environment (β = .242, p = .000) all experienced a worse personal wellbeing. The participants that were (very) satisfied (β = -.276, p = .000) and (very) unsatisfied (β = -.215, p = .001) experienced a better personal wellbeing in comparison with the neutral participants. Lastly, participants that gave higher marks for the dwelling they lived in, experienced a better personal wellbeing (β = -.189, p = .000).

Adding the social characteristics in the fully adjusted model (table 1), did not alter the significance levels and only slightly change the magnitude of the coefficients. Participants that disagreed with the statement that people treat each other in a pleasant way (β = .208, p = .005), experienced a worse personal wellbeing than the neutral participants. Participants that agreed with the statement that it was a sociable neighbourhood (β = -.192, p = .000), agreed that there was a lot of interaction (β = -.216, p = .000) and disagreed that there was a lot of interaction (β = -.108, p = .010) and agreed that they were comfortable with people living in the neighbourhood (β = -.265, p = .000) all experienced a better personal wellbeing then the neutral participants.

Resilience

Resilience was analysed in the second regression (table 2). The unadjusted model, including personal characteristics, showed some significant variables. Participants with a Western (β = .687, p = .000) and non-Western (β = 1.290, p = .000) background were less resilient as Dutch participants. Furthermore, participants that were women (β = -.155, p = .001) and had a medium (β = -.618, p = .000) or higher (β = -1.032, p = .000) education relative to a low education, were more resilient. The participants with an income of €1600-€2150 were more resilient than the lowest group (β = -.365, p = .000) which significantly increased even more in the €2150-€3500 (β = -.405, p = .000) and >€3500 (β = -.481, p = .000) groups in comparison to the lowest income group.

Adding the environmental characteristics in the unadjusted model (table 2), did not change the significance levels. Participants living in a multi-family home were less resilient than participants living in a single-family home (β = .108, p = .044), and the participants living in a house owned by a rental housing corporation were less resilient (β = .172, p = .010) in comparison with participants who owned their dwelling. Furthermore, participants that labelled their neighbourhood as unpleasant relative to pleasant (β = -.191, p = .035), were both (very) satisfied (β = -.186, p = .005) and (very) dissatisfied (β = -.325, p = .000) with greenery in the neighbourhood, suffered from noise nuisance (β = -.140, p = .024), gave higher report marks for their dwelling (β = -.098, p = .000) and lived in a urban environment rather than a very strongly urban environment (β = -.281, p = .002) were more resilient.

Adding the social characteristics in the fully adjusted model (table 2), did alter the significance levels for some of the covariates. The association of neighbourhood satisfaction became insignificant for the unpleasant versus pleasant participants. This was also the case for the multi family dwelling versus single family dwellings. Participants that stated that there was a lot of interaction in the neighbourhood, were less resilient (β = .165, p = .015). Participants that agreed (β = -.200, p = .002) and disagreed (β = -.392, p = .000) with the statement that people don't know each other, agreed on the statement that people treat each other in a pleasant way (β = -.211, p = .001) and disagreed on the statement that it was a sociable neighbourhood (β = -.208, p = .022), were all more resilient then the neutral participants.

Mental illness

Mental illness was analysed in the last regression (table 3). The unadjusted model, including personal characteristics, showed some significant variables. Participants with an income of €1150-€1600 were more likely to have a mental illness (β = .447, p = .018) than participants with a monthly income of <€1150 (lowest group). Participants that were older (β = -.675, p = .000), had a non-Western background in comparison to a Dutch background (β = -.597, p = .001), were higher educated (β = -.597, p = .001) and belong to the €2150-€3500 (β = -.1.000, p = .000) or >€3500 (β = -.1.112, p = .000) income group relative to the lowest group, were less likely to have a mental illness.

Adding the environmental characteristics in the unadjusted model (table 3), did change a significance level. The association of the €1150-€1600 income group versus the <€1150 group became insignificant. Participants that suffered from noise nuisance (β = .398, p = .049) and lived in a house owned by a rental housing corporation rather than owning their dwelling (β = .591, p = .001), were more likely to have a mental illness. Lastly, participants with higher report marks were less likely to have a mental illness (β = -.146, p = .001). No significant associations were found between mental illness and social characteristics.

Table 1: Results of the linear regression models for Personal wellbeing

	Model 1				Model 2				Model 3				Model 4			
	Unstand. B	**Std. Error**	**Stand. B**	**P-value**	**Unstand. B**	**Std. Error**	**Stand. B**	**P-value**	**Unstand. B**	**Std. Error**	**Stand. B**	**P-value**	**Unstand. B**	**Std. Error**	**Stand. B**	**P-value**
Personal wellbeing																
Intercept	3.861	0.022		0.000	3.978	0.075		0.000	5.226	0.136		0.000	5.482	0.140		0.000
Range: 300-600m (ref: <300m)	-.022	0.039	-0.007	0.574	-0.010	0.037	-0.003	0.776	-0.009	0.036	-0.003	0.802	-0.004	0.035	-0.001	0.920
Range: 600-900m (ref: <300m)	0.016	0.061	0.003	0.788	0.008	0.058	0.002	0.889	-0.040	0.057	-0.008	0.480	-0.027	0.056	-0.006	0.627
Age					0.007	0.001	0.086	0.000	0.009	0.001	0.109	0.000	0.008	0.001	0.101	0.000
Gender (ref: Men)					-0.258	0.033	-0.091	0.000	-0.216	0.032	-0.077	0.000	-0.186	0.032	-0.066	0.000
Ethnicity: Western (ref: Dutch)					0.042	0.056	0.009	0.457	0.020	0.054	0.004	0.717	0.039	0.053	0.008	0.460
Ethnicity: non-Western (ref: Dutch)					0.227	0.042	0.068	0.000	0.073	0.042	0.022	0.084	0.073	0.042	0.022	0.082
Education: Medium (ref: Low)					-0.024	0.057	-0.007	0.668	0.031	0.055	0.009	0.578	0.010	0.055	0.003	0.851
Education: High (ref: Low)					-0.189	0.053	-0.065	0.000	-0.124	0.052	-0.042	0.017	-0.115	0.051	-0.039	0.025
Income: €1150-€1600 (ref: <€1150)					0.180	0.065	0.035	0.006	0.133	0.063	0.026	0.035	0.151	0.062	0.030	0.016
Income: €1600-€2150 (ref: <€1150)					-0.001	0.059	0.000	0.985	-0.030	0.057	-0.007	0.602	-0.019	0.056	-0.004	0.734
Income: €2150-€3500 (ref: <€1150)					-0.218	0.050	-0.063	0.000	-0.177	0.049	-0.051	0.000	-0.164	0.049	-0.047	0.001
Income: >€3500 (ref: <€1150)					-0.666	0.048	-0.213	0.000	-0.527	0.048	-0.169	0.000	-0.487	0.048	-0.156	0.000
Unpleasant neighbourhood (ref: Pleasant neighbourhood)									0.395	0.062	0.078	0.000	0.220	0.068	0.043	0.001
Park satisfaction: (very) Satisfied (ref: Neutral)									-0.276	0.046	-0.090	0.000	-0.228	0.046	-0.074	0.000
Park satisfaction: (very) Unsatisfied (ref: Neutral)									-0.215	0.063	-0.049	0.001	-0.194	0.062	-0.044	0.002
Greenery satisfaction: (very) Pleasant (ref: Neutral)									-0.043	0.045	-0.015	0.341	-0.010	0.045	-0.003	0.830
Greenery satisfaction: (very) Unpleasant (ref: Neutral)									0.021	0.057	0.005	0.716	0.039	0.056	0.010	0.487
Noise nuisance: Yes (ref: No)									0.148	0.042	0.042	0.000	0.118	0.042	0.033	0.005
Air pollution: Yes (ref: No)									0.060	0.034	0.021	0.079	0.043	0.034	0.015	0.203
Type dwelling: Multi-family (ref: single-family)									0.062	0.037	0.022	0.093	0.020	0.037	0.007	0.589
Owner/Rental: Rental (Housing corporation) (ref: Owner)									0.005	0.045	0.002	0.914	-0.023	0.045	-0.008	0.603
Owner/Rental: Rental (Private) (ref: Owner)									-0.065	0.050	-0.018	0.195	-0.068	0.050	-0.018	0.172
Report mark dwelling									-0.189	0.012	-0.199	0.000	-0.166	0.012	-0.175	0.000
Urbanity: Strongly urban (ref: Very strongly urban)									0.242	0.041	0.071	0.000	0.211	0.041	0.062	0.000
Urbanity: Urban (ref: Very strongly urban)									0.090	0.060	0.018	0.134	0.046	0.060	0.009	0.436
Urbanity: Less urban (ref: Very strongly urban)									-0.438	0.340	-0.015	0.197	-0.371	0.335	-0.012	0.268
Urbanity: Not urban (ref: Very strongly urban)									0.188	0.154	0.014	0.221	0.187	0.152	0.014	0.219
Neighbourhood: Relations Agree (ref: Neutral)													-0.085	0.044	-0.030	0.056
Neighbourhood: Relations Disagree (ref: Neutral)													-0.007	0.048	-0.002	0.890
Neighbourhood: Treatment Agree (ref: Neutral)													-0.027	0.043	-0.009	0.532
Neighbourhood: Treatment Disagree (ref: Neutral)													0.208	0.075	0.036	0.005
Neighbourhood: Sociability Agree (ref: Neutral)													-0.192	0.042	-0.067	0.000
Neighbourhood: Sociability Disagree (ref: Neutral)													-0.050	0.061	-0.011	0.413
Neighbourhood: Interaction Agree (ref: Neutral)													-0.216	0.046	-0.065	0.000
Neighbourhood: Interaction Disagree (ref: Neutral)													-0.108	0.042	-0.036	0.010
Neighbourhood: Comfort agree (ref: Neutral)													-0.265	0.043	-0.091	0.000
Neighbourhood: Comfort disagree (ref: Neutral)													-0.005	0.075	-0.001	0.941

Table 2: Results of the linear regression models for Resilience

	Model 1				Model 2				Model 3				Model 4			
	Unstand. B	**Std. Error**	**Stand. B**	**P-value**	**Unstand. B**	**Std. Error**	**Stand. B**	**P-value**	**Unstand. B**	**Std. Error**	**Stand. B**	**P-value**	**Unstand. B**	**Std. Error**	**Stand. B**	**P-value**
Resilience																
Intercept	4.787	0.034		0.000	5.597	0.107		0.000	6.415	0.200		0.000	6.761	0.207		0.000
Range: 300-600m (ref: <300m)	0.007	0.058	0.002	0.904	0.022	0.052	0.005	0.669	0.025	0.052	0.006	0.634	0.021	0.052	0.005	0.685
Range: 600-900m (ref: <300m)	0.136	0.091	0.019	0.136	0.018	0.083	0.002	0.833	0.030	0.084	0.004	0.720	0.039	0.084	0.005	0.644
Age					1.018	0.001	0.000	0.994	0.002	0.002	0.019	0.133	0.002	0.002	0.014	0.252
Gender (ref: Men)					-0.155	0.048	-0.037	0.001	-0.137	0.048	-0.033	0.004	-0.122	0.047	-0.029	0.010
Ethnicity: Western (ref: Dutch)					0.687	0.080	0.099	0.000	0.665	0.079	0.096	0.000	0.653	0.079	0.094	0.000
Ethnicity: non-Western (ref: Dutch)					1.290	0.061	0.258	0.000	1.179	0.063	0.236	0.000	1.131	0.063	0.227	0.000
Education: Medium (ref: Low)					-0.618	0.081	-0.116	0.000	-0.551	0.082	-0.104	0.000	-0.541	0.081	-0.102	0.000
Education: High (ref: Low)					-1.032	0.075	-0.238	0.000	-0.996	0.076	-0.230	0.000	-0.947	0.076	-0.218	0.000
Income: €1150-€1600 (ref: <€1150)					-0.049	0.093	-0.006	0.597	-0.125	0.093	-0.017	0.181	-0.111	0.093	-0.015	0.233
Income: €1600-€2150 (ref: <€1150)					-0.339	0.083	-0.052	0.000	-0.365	0.083	-0.056	0.000	-0.355	0.083	-0.054	0.000
Income: €2150-€3500 (ref: <€1150)					-0.449	0.071	-0.088	0.000	-0.405	0.072	-0.079	0.000	-0.402	0.072	-0.079	0.000
Income: >€3500 (ref: <€1150)					-0.613	0.069	-0.133	0.000	-0.481	0.071	-0.104	0.000	-0.455	0.071	-0.098	0.000
Unpleasant neighbourhood (ref: Pleasant neighbourhood)									-0.191	0.090	-0.025	0.035	-0.192	0.101	-0.026	0.056
Park satisfaction: (very) Satisfied (ref: Neutral)									-0.045	0.068	-0.010	0.505	-0.019	0.068	-0.004	0.778
Park satisfaction: (very) Unsatisfied (ref: Neutral)									-0.021	0.092	-0.003	0.817	0.008	0.092	0.001	0.934
Greenery satisfaction: (very) Pleasant (ref: Neutral)									-0.186	0.067	-0.042	0.005	-0.158	0.066	-0.036	0.017
Greenery satisfaction: (very) Unpleasant (ref: Neutral)									-0.325	0.083	-0.057	0.000	-0.277	0.083	-0.049	0.001
Noise nuisance: Yes (ref: No)									-0.140	0.062	-0.027	0.024	-0.146	0.062	-0.028	0.018
Air pollution: Yes (ref: No)									0.009	0.051	0.002	0.861	0.000	0.050	0.000	0.993
Type dwelling: Multi-family (ref: single-family)									0.108	0.054	0.026	0.044	0.089	0.055	0.021	0.105
Owner/Rental: Rental (Housing corporation) (ref: Owner)									0.172	0.067	0.037	0.010	0.146	0.066	0.032	0.028
Owner/Rental: Rental (Private) (ref: Owner)									0.091	0.074	0.017	0.220	0.080	0.074	0.015	0.279
Report mark dwelling									-0.098	0.018	-0.069	0.000	-0.092	0.018	-0.065	0.000
Urbanity: Strongly urban (ref: Very strongly urban)									0.012	0.060	0.002	0.845	0.016	0.060	0.003	0.789
Urbanity: Urban (ref: Very strongly urban)									-0.281	0.089	-0.038	0.002	-0.275	0.088	-0.037	0.002
Urbanity: Less urban (ref: Very strongly urban)									0.066	0.517	0.001	0.898	0.133	0.515	0.003	0.796
Urbanity: Not urban (ref: Very strongly urban)									0.174	0.225	0.009	0.437	0.239	0.224	0.012	0.286
Neighbourhood: Relations Agree (ref: Neutral)													-0.200	0.066	-0.048	0.002
Neighbourhood: Relations Disagree (ref: Neutral)													-0.392	0.071	-0.086	0.000
Neighbourhood: Treatment Agree (ref: Neutral)													-0.211	0.064	-0.047	0.001
Neighbourhood: Treatment Disagree (ref: Neutral)													0.215	0.111	0.025	0.053
Neighbourhood: Sociability Agree (ref: Neutral)													0.004	0.061	0.001	0.952
Neighbourhood: Sociability Disagree (ref: Neutral)													-0.208	0.090	-0.032	0.022
Neighbourhood: Interaction Agree (ref: Neutral)													0.165	0.068	0.033	0.015
Neighbourhood: Interaction Disagree (ref: Neutral)													-0.099	0.062	-0.023	0.109
Neighbourhood: Comfort agree (ref: Neutral)													-0.100	0.064	-0.023	0.115
Neighbourhood: Comfort disagree (ref: Neutral)													-0.094	0.111	-0.012	0.398

Table 3: Results of the binary logistic regression models for Mental illness

	Model 1				Model 2				Model 3				Model 4			
	Unstand. B	**Std. Error**	**Stand. B**	**P-value**	**Unstand. B**	**Std. Error**	**Stand. B**	**P-value**	**Unstand. B**	**Std. Error**	**Stand. B**	**P-value**	**Unstand. B**	**Std. Error**	**Stand. B**	**P-value**
Mental illness																
Intercept	-3.237	0.084	0.039	0.000	-1.446	0.254	0.236	0.000	-1.223	0.498	0.294	0.014	-1.121	0.518	0.326	0.030
Range: 300-600m (ref: <300m)	0.237	0.134	1.268	0.077	0.250	0.136	1.285	0.067	0.304	0.139	1.355	0.029	0.301	0.140	1.351	0.031
Range: 600-900m (ref: <300m)	-0.300	0.260	0.741	0.249	-0.243	0.263	0.785	0.356	-0.249	0.268	0.779	0.353	-0.243	0.269	0.784	0.367
Age					-0.023	0.004	0.978	0.000	-0.023	0.004	0.978	0.000	-0.023	0.004	0.977	0.000
Gender (ref: Men)					-0.061	0.130	0.941	0.638	-0.020	0.131	0.980	0.878	-0.023	0.132	0.977	0.862
Ethnicity: Western (ref: Dutch)					-0.031	0.210	0.970	0.884	-0.075	0.214	0.928	0.726	-0.074	0.214	0.929	0.731
Ethnicity: non-Western (ref: Dutch)					-0.675	0.170	0.509	0.000	-0.998	0.183	0.368	0.000	-1.022	0.185	0.360	0.000
Education: Medium (ref: Low)					-0.063	0.188	0.939	0.737	0.002	0.192	1.002	0.991	0.013	0.193	1.013	0.946
Education: High (ref: Low)					-0.597	0.187	0.550	0.001	-0.555	0.195	0.574	0.004	-0.530	0.197	0.589	0.007
Income: €1150-€1600 (ref: <€1150)					0.447	0.188	1.564	0.018	0.304	0.193	1.356	0.114	0.308	0.193	1.360	0.111
Income: €1600-€2150 (ref: <€1150)					-0.240	0.208	0.787	0.248	-0.282	0.211	0.754	0.182	-0.278	0.212	0.757	0.189
Income: €2150-€3500 (ref: <€1150)					-1.000	0.221	0.368	0.000	-0.883	0.224	0.413	0.000	-0.890	0.225	0.411	0.000
Income: >€3500 (ref: <€1150)					-1.112	0.210	0.329	0.000	-0.822	0.220	0.440	0.000	-0.820	0.220	0.440	0.000
Unpleasant neighbourhood (ref: Pleasant neighbourhood)									0.058	0.212	1.060	0.784	0.020	0.240	1.020	0.935
Park satisfaction: (very) Satisfied (ref: Neutral)									-0.235	0.179	0.790	0.188	-0.229	0.180	0.796	0.204
Park satisfaction: (very) Unsatisfied (ref: Neutral)									-0.032	0.236	0.968	0.892	-0.024	0.237	0.976	0.919
Greenery satisfaction: (very) Pleasant (ref: Neutral)									0.323	0.192	1.381	0.092	0.321	0.193	1.379	0.095
Greenery satisfaction: (very) Unpleasant (ref: Neutral)									0.045	0.235	1.046	0.847	0.046	0.236	1.047	0.845
Noise nuisance: Yes (ref: No)									0.398	0.202	1.488	0.049	0.401	0.203	1.494	0.048
Air pollution: Yes (ref: No)									0.188	0.140	1.207	0.178	0.188	0.140	1.207	0.180
Type dwelling: Multi-family (ref: single-family)									0.032	0.147	1.032	0.830	0.051	0.150	1.052	0.735
Owner/Rental: Rental (Housing corporation) (ref: Owner)									0.591	0.175	1.806	0.001	0.590	0.176	1.804	0.001
Owner/Rental: Rental (Private) (ref: Owner)									0.043	0.212	1.044	0.838	0.067	0.214	1.069	0.754
Report mark dwelling									-0.146	0.043	0.864	0.001	-0.145	0.043	0.865	0.001
Urbanity: Strongly urban (ref: Very strongly urban)									0.169	0.167	1.184	0.311	0.169	0.167	1.184	0.312
Urbanity: Urban (ref: Very strongly urban)									-0.308	0.298	0.735	0.301	-0.306	0.299	0.737	0.306
Urbanity: Less urban (ref: Very strongly urban)									1.096	1.095	2.992	0.317	1.043	1.100	2.838	0.343
Urbanity: Not urban (ref: Very strongly urban)									0.025	0.462	1.025	0.957	0.055	0.465	1.056	0.906
Neighbourhood: Relations Agree (ref: Neutral)													-0.097	0.179	0.908	0.588
Neighbourhood: Relations Disagree (ref: Neutral)													0.036	0.200	1.037	0.857
Neighbourhood: Treatment Agree (ref: Neutral)													-0.148	0.170	0.862	0.384
Neighbourhood: Treatment Disagree (ref: Neutral)													0.158	0.268	1.172	0.554
Neighbourhood: Sociability Agree (ref: Neutral)													-0.109	0.172	0.897	0.527
Neighbourhood: Sociability Disagree (ref: Neutral)													-0.146	0.236	0.864	0.535
Neighbourhood: Interaction Agree (ref: Neutral)													0.001	0.195	1.001	0.996
Neighbourhood: Interaction Disagree (ref: Neutral)													-0.072	0.170	0.930	0.671
Neighbourhood: Comfort agree (ref: Neutral)													0.154	0.177	1.166	0.387
Neighbourhood: Comfort disagree (ref: Neutral)													0.142	0.267	1.153	0.594

4. Discussion

The aim of this study was to determine the association between the proximity of urban green space and mental health, with a further understanding of the underlying pathways based on personal, environmental and social characteristics. The results show that participant living closer to urban green (within 300m), are less likely to have a mental illness than participants living further away (300-600m), only after controlling for personal and environmental characteristics. Environmental characteristics thus have a larger role in explaining proximity to urban green regarding mental illness. No significant association between proximity of urban green and personal wellbeing or resilience was found.

4.1 Proximity to urban green and self-reported mental illness

The result for the association of proximity and having a mental illness partly confirm the first hypothesis and corroborate prior research. Negative associations between the presence of a psychotic disorder and living close to urban green is in line with previous studies (Boers et al., 2018; de Vries et al., 2003; J. Maas et al., 2009; Nutsford et al., 2013). The positive influence of urban green is associated with depressive disorders, psychiatric distress and symptoms, clinical anxiety and mood disorders (Astell-Burt et al., 2013; K. C. Fong et al., 2018; Nutsford et al., 2013; Sarkar et al., 2018; M. van den Berg et al., 2015). The finding that this association only occurred within a 300m distance from urban green, is not always supported. The distance in which it is suggested that urban green would have an effect on mental health, thus varies a lot. Studies using the same or similar ranges to the nearest park, found the same results suggesting that the mental health is mostly affected in the smallest range buffer of 300m (Dzhambov, Markevych, Hartig, et al., 2018; Dzhambov, Markevych, Tilov, et al., 2018; Gascon et al., 2018; Houlden et al., 2019; Triguero-Mas et al., 2015; Watts et al., 2013). Other studies extend on this finding and indicate that this association is present over multiple buffer ranges. Associations were for instance found in both 400m and 800m ranges (Bojorquez & Ojeda-Revah, 2018; Duncan et al., 2013). The findings of the current study are furthermore contradictory with other studies that found no significant associations within a 300m range (Nutsford et al., 2013), while others only found associations in larger buffer ranges starting at 1km (Jolanda Maas et al., 2009) or 3km (Bos et al., 2016; de Vries et al., 2003; A. E. van den Berg et al., 2010) or both (Jolando Maas et al., 2006).

4.2 Underlying pathways

This association of proximity to urban green and mental illness being dependent on environmental pathways, is in line with previous studies (Nieuwenhuijsen et al., 2017; Twohig-Bennett & Jones, 2018) and partly confirms the second hypothesis. As the results of this study affirm, noise nuisance is an important factor in terms of this environmental pathway. Previous studies agree on the fact that

urban parks mitigate this noise nuisance which reduces morbidity of mental illness (Dzhambov, Markevych, Tilov, et al., 2018). The availability of nearby green thus reduces noise nuisance in the form of traffic, construction, companies and neighbours resulting in a decrease of prevalence of stress-related psychosocial symptoms, depressive symptoms, noise annoyance and increase in outdoor space usage, which is in line with the results of this study (Gidlöf-Gunnarsson & Öhrström, 2007; Hammersen et al., 2016; Tzivian et al., 2015).

The next environmental variables that were important in the association between proximity to urban green and mental illness, was homeownership and appreciation for the dwelling (in the form of a report mark). Being the owner of a dwelling results in less depressive symptoms in comparison to renting a dwelling as stated elsewhere and confirmed in the current study (Park & Seo, 2020). Furthermore, better mental health scores are often associated with the construction of the building itself as suggested in the current study. This refers to the overall appreciation which consists of for instance the number of units per apartment, density, quality and condition, floor level and more (Assari et al., 2016). Although this association might be sensitive to the subjectivity of appreciation for ones dwelling as stated elsewhere (Ettema & Schekkerman, 2016), poor housing conditions are considered to affect mental health and increase the likelihood of being mentally ill (Fernández-Portero et al., 2017; Pevalin et al., 2017).

4.3 Proximity to urban green and self-reported personal wellbeing and resilience

Proximity to urban green was not significantly associated to the other mental health constructs namely personal wellbeing and resilience after controlling for personal, environmental and social characteristics however the magnitudes were noteworthy. Living further away from urban green resulted in the expected effect of participants being less resilient which is in line with other studies (Buchecker & Degenhardt, 2015; Dzhambov et al., 2019; Flouri et al., 2014).

According to the results living closer to urban green induces a worse personal wellbeing which contrasts with most studies. A possible explanation would be the geography of the study area in combination with the ranges of the buffer sizes that were used. As the urban green spaces are scattered around the inner parts of Utrecht, a pattern is created in which the residents that live further away from urban green, also live closer to the borders of the city that is surrounded by forests and robust nature. These participants thus still have accessibility to green albeit not in the form of urban green. The relatively large ranges of the buffer sizes created a lot of overlap in the dense inner parts of the city, resulting in most of the participants being in close proximity to urban green. Similar problems were found in other studies on self-reported health advocating for smaller buffer sizes (Dadvand et al., 2012; Orban et al., 2017; Reid et al., 2017).

The main mechanisms underlying the association of mental health and green space, can be linked to two theories. The Attention Restoration Theory of Kaplan proposes that nature offers the stimuli to

allow restoration from attention fatigue, which take place during the execution of cognitive tasks that require continuation of directed attention (R. Kaplan & Kaplan, 1989). This restoration is assumed to occur because the natural environment provides qualities that promote the absence of routine thoughts and activities and improve the fascination with natural features that attract effortless attention (S. Kaplan, 1995). The psycho-evolutionary perspective of Ulrich's Stress Recovery Theory claims that nature allow psychosociological stress recovery through innate, adaptive responses to natural features including the presence of pattern of structure, water and spatial openness. The perception of these characteristics activates positive emotional reactions that relate to survival and safety (Ulrich, 1983).

4.4 Strengths and limitations

Several strengths of this study need to be emphasized. A large dataset was used that was representative for the Netherlands. Based on multiple ethnic and age categories, a robust sample for the different neighbourhoods of Utrecht could be selected which makes the findings easier to generalize. The way the questionnaire used in this study is administered and processed is a standardized process that has been probed for over 20 years making it a reliable tool. Furthermore, this research addresses multiple aspects of mental health resulting in a better understanding of this multidimensional factor on an individual and neighbourhood level. In addition, personal, environmental and social characteristics were taken into account simultaneously, which allowed to examine the relationship between these underlying pathways.

Multiple limitations should be taken into consideration when interpreting the results of this study. While the models are controlled for socio-economic status and demographics, they remained unadjusted for other factors that are acknowledged to influence mental health. Factors that should be considered are for instance physical activity, social networks, activities in urban green and lifestyle (Hoogerbrugge & Burger, 2018; Knowlden et al., 2015; Andrew Chee Keng Lee et al., 2015; Simons et al., 2019; Wang, Liu, et al., 2019). Second, the measurement of urban green was limited to urban parks (which make up at least 60% of Utrecht's greenery) for the sake of this study which might neglect the influence of other forms of green like vegetation outside of parks or private gardens (Cervinka et al., 2016). Attention restoration and stress recovery is considered to occur in other types of green spaces which were not included in this study (Akpinar et al., 2016). In addition, the exposure to green space along people's daily life or over the course of their life was not taken into account while proven to be influential (Helbich, 2018; Kwan, 2018; Li et al., 2018). Furthermore, the measurements were mostly subjective (like self-reported mental health) which might not be completely representative as stated elsewhere (Bharadwaj et al., 2017). The lack of information on attitudes and motives for participants to live in a certain neighbourhood could also resulted in a self-selecting bias (Zhang, 2014). This self-selection bias could also be of influence when sampling the participants by sending a letter. People who were willing to participate, might already be in better

mental health conditions. Also, since the letter is from a governmental institution, certain groups might not respond because of trust, aversion or the feeling of having no external control on society. And lastly due to the cross-sectional research design, no causal statements could be made.

5. Conclusion

This cross-sectional study explored the association between proximity to urban green and mental health, while taking into consideration personal, environmental and social characteristics. The results of the regression models suggested that proximity to urban green was only significantly associated with mental illness after adjusting for environmental characteristics within 300m. The association was thus dependent on environmental pathways rather than personal or social pathways. Important variables in this association were noise nuisance, homeownership and report mark. Participants suffering from noise nuisance, rented their dwelling rather than owning their dwelling and giving a lower report mark, were more likely to have a mental illness. No significant associations were found for proximity to urban green and personal wellbeing or resilience. The association between proximity to urban green and mental health and the underlying characteristics, is thus complicated and needs more research focussing on mental health aspects and the interplay of the different pathways. Future studies should focus on implementing all the underlying pathways into their research design. As indicated by previous studies and confirmed by the current study, this should be in a simultaneous way while taking into consideration multiple aspects of mental health to untangle the interplay between personal, environmental and social pathways underlying the association between urban green and mental health. A subsequent study should be longitudinal and checking for physical activity, social networks, activities in urban green and lifestyle.

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