

# Compact city, urban sprawl, and subjective well-being

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## ABSTRACT

Understanding the role of the built environment in subjective well-being (SWB) can provide important input to urban planning debates on synergies and conflicts between environmental and social sustainability of cities. Hitherto, there is little empirical evidence on how SWB is shaped by compact versus low-density sprawled urban form. This paper investigates this topic using survey data collected in Oslo metropolitan area. In addition to SWB measures, the paper examines life domains as intermediate variables between urban form and SWB. Findings suggest that, compared with residents of lower-density neighborhoods, compact-city residents have higher levels of personal relationships satisfaction and perceived physical health, similar levels of leisure satisfaction, but lower levels of emotional response to neighborhood and higher levels of anxiety. Potential benefits of the compact city for personal relationships and physical health seem to be at least partially cancelled out by lower emotional response to neighborhood and increased anxiety. Compact urban form has nonsignificant associations with life satisfaction, eudaimonia, and happiness. However, when additionally controlling for variables relevant to urban problems – perceived safety, noise, and cleanliness – emotional response to compact neighborhoods becomes significantly positive and the impact of anxiety diminishes, resulting in a significant positive association of compactness with life satisfaction. This study's outcomes are encouraging for urban sustainability as they indicate that moderately high-density development does not negatively influence SWB, as is often claimed, and that by addressing problems such as fear of crime, noise, and litter, it has the potential to promote SWB.

## 1. Introduction

Does urban form influence subjective well-being (SWB)? If so, how is this influence shaped? These are crucial questions for the future development of human settlements as they concern both their environmental and social sustainability. On the one hand, the form that cities take can affect environmental sustainability as there is plenty of evidence showing that compact urban forms are in general friendlier to the environment than those that are dispersed (e.g. Meyer, 2013; Newman & Kenworthy, 1999). On the other hand, achieving high levels of SWB, a personal evaluation of one's life (Diener, 2000), is one of the most important life as well as political goals (Stiglitz, Sen, & Fitoussi, 2009; Veenhoven, 2012), a major goal of urban planning (Thin, 2012), and a key indicator of social sustainability (Cloutier & Pfeiffer, 2015; Kyttä, Broberg, Haybatollahi, & Schmidt-Thomé, 2016; Moser, 2009). Examining the relationship between urban form and SWB can therefore unveil both synergies and conflicts between environmental and social sustainability, with various implications for environmental issues such as climate change, environmental degradation, pollution, and depletion of natural resources in relation to human well-being and human development.

Although these are such important questions, empirical research has only recently started to systematically explore the relationship between the built environment and SWB. Researchers have been investigating this relationship on large geographical scales comparing different settlements at country level (Ballas & Tranmer, 2012; Morrison & Weckroth, 2017; Okulicz-Kozaryn & Mazelis, 2018) but also on smaller scales within city regions (Cao, 2016; Ettema & Schekkerman, 2016; Feng, Tang, & Chuai, 2017; Kyttä et al., 2016). Despite some indications that residents of larger metropolitan areas are less happy compared with residents of smaller metropolitan areas, we still do not have enough evidence on how the urban form within a given city region affects SWB. Our knowledge on whether denser or more dispersed, sprawled urban forms promote higher SWB is limited. Even more importantly, we lack understanding of the mechanisms under which different urban forms influence SWB. Statistical associations between urban form measures and SWB provide useful insights but do not offer in-depth understanding of the different ways in which residents' lives are affected by the level of compactness of urban form. Such an understanding would not only provide theoretical advancements in the field but also well-founded input for policymakers.

This paper aims to offer relevant empirical insights by investigating

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how the compactness of the urban form within a given metropolitan area may influence SWB. To investigate this issue, the conceptual framework by Mouratidis (2018c) on the built environment and SWB is applied to survey data collected in the metropolitan area of Oslo. This framework links together built environment characteristics with relevant SWB determinants – life domains that are influenced by the built environment and in turn influence SWB – and measures of SWB. The paper answers two main research questions: (1) How does compactness affect relevant SWB determinants (personal relationships, leisure activities, health, emotional response to neighborhood) and eventually SWB itself (life satisfaction, eudaimonia, hedonic well-being)? (2) How does this effect change when we additionally control for common urban problems: fear of crime, noise, and litter?

Oslo's inner city is mostly characterized by compact development and its suburbs are mostly characterized by low-density sprawled development. By examining the role of compact versus more dispersed urban forms in SWB, the paper aims to provide important input to urban planning debates about the social sustainability merits of more versus less environmentally friendly urban development, namely densification versus outward urban expansion. Although previous research in Oslo suggests that, compared with low-density suburban residents, compact-city residents feel that their neighborhood covers their needs to a greater degree (Mouratidis, 2017) and have higher social well-being (Mouratidis, 2018a), it remains to be seen if this is translated into higher overall SWB.

With the world population rapidly increasing and urban populations growing, the compact city paradigm is widely considered a necessity for controlling relevant environmental consequences, and thus has been endorsed as a future development strategy by several leading institutions (European Commission, 2007; United Nations, 2012). Similarly, Oslo's population is rapidly growing, and in order to preserve farmlands and forests, protect biodiversity from potential urban expansion and avoid an increase in car travel, the city has decided to focus on densification policies. Based on these considerations of environmental sustainability, this study explores the second aforementioned research question, examining the role of common problems of high-density urbanized areas in SWB. Fear of crime, litter, and noise are important urban problems (Howley, Scott, & Redmond, 2009) that have been found to be significantly higher in compact areas (Mouratidis, 2017). Assessing the impact of these problems, along with measures of urban form compactness, can provide indications of how important they are for SWB, but also how SWB in compact areas might change should they be mitigated.

To sum up, the contribution of the paper is threefold. (a) It offers new insights into whether it is compact or low-density urban forms that influence SWB more positively, revealing synergies and conflicts between environmental and social sustainability. (b) It investigates the ways in which urban form shapes SWB by applying a new conceptual and methodological approach that examines the indirect effects of urban form attributes on SWB through relevant SWB determinants. Thus, it attempts to unveil causal mechanisms and offer a new paradigm for further relevant research. (c) By additionally assessing the role of common urban problems, it provides input for practitioners and policymakers on how to improve the livability of compact cities.

## 2. Literature review

### 2.1. Urban form and SWB determinants

Major viewpoints on SWB and relevant suggested measures are classified as life satisfaction, eudaimonia, and hedonic well-being (also called emotional well-being or affect) (Dolan & Metcalfe, 2011; OECD, 2013; Sirgy, 2012). These components of SWB are strongly moderated by personality traits such as extraversion and neuroticism (Diener & Lucas, 1999). Various life domains also contribute to SWB. The built environment can influence some of these, namely personal

relationships, leisure activities, health, and emotional response to neighborhood (Mouratidis, 2018c).

High-density urban forms are associated with looser neighbor ties (Bramley, Dempsey, Power, Brown, & Watkins, 2009; Fischer, 1982; Mouratidis, 2017), but also with larger social networks, more opportunities to make new acquaintances, higher frequency of socializing, stronger social support, and higher personal relationships satisfaction (Mouratidis, 2018a). Residents of compact cities have been found to walk more compared with residents of low-density areas (Ewing, Schmid, Killingsworth, Zlot, & Raudenbush, 2003), possibly leading to physical health benefits (Stevenson et al., 2016; Sturm & Cohen, 2004). However, urban life has also been associated with higher stress (Lederbogen et al., 2011) and high-rise living with psychological problems (Gifford, 2007). Despite previous research works examining impacts of the urban form on personal relationships, leisure, health, and emotional response to neighborhood, there is little evidence on how these impacts may contribute to overall SWB.

### 2.2. Urban form and SWB

Regional studies have been investigating relationships between urban form measures and SWB measures on a large scale by comparing different regions within a country. There is evidence suggesting that residents of smaller settlements, usually villages or small towns, are happier compared with residents of big metropolitan areas (Ballas & Tranmer, 2012; Berry & Okulicz-Kozaryn, 2011; Morrison, 2011; Okulicz-Kozaryn & Mazelis, 2018; Sørensen, 2014). This negative association between large cities and SWB has been attributed to the different values that their residents hold, for example a possible excessive desire for power and achievement (Morrison & Weckroth, 2017).

Urban studies, on the other hand, have been exploring the relationship between the built environment and SWB on a finer scale within specific city regions. Several aspects of the built environment have been related to SWB, such as density, land use, greenness, transportation, and nuisances (Hajrasouliha, del Rio, Francis, & Edmonson, 2018). Some studies suggest that neighborhood environmental quality and safety positively contribute to SWB (Ettema & Schekkerman, 2016; Kyttä et al., 2016). Findings from studies on Bandung, London, and Beijing indicate that shorter distances to city center may positively influence SWB (Arifwidodo & Perera, 2011; MacKerron & Mourato, 2009; Wang & Wang, 2016). This positive influence could be due to facilitated travel (Næss, 2005) and higher access to facilities (Burton, 2000; Mouratidis, 2017), which have been found to be positively associated with SWB in cities (Leyden, Goldberg, & Michelbach, 2011). Nevertheless, despite useful evaluations of accessibility and SWB, the cases on Bandung, London, and Beijing do not include low-density areas to a large extent in order to evaluate potential benefits of living in such places and to draw comparisons with compact areas.

Few studies have been assessing the role of compact versus low-density urban forms in SWB. Compact development can offer easy access to facilities, people, and workplaces but low-density development, in contrast, can offer quietness, access to nature, higher perceived safety and cleanliness, and stronger neighbor ties (Mouratidis, 2017). A relevant study suggests that the relationship between urban form and SWB depends on the SWB measure: self-reported quality of life was found higher in central pedestrian areas, while happiness was higher in car-oriented areas (Ala-Mantila, Heinonen, Junnila, & Saarsalmi, 2018). An analysis based in Oslo finds a negative association between population density and SWB (Cramer, Torgersen, & Kringle, 2004). However, the researchers of this study use physical health as a control variable in their regression models. This was also done by Okulicz-Kozaryn and Mazelis (2018) who control for health as well as social support. As described above, both health and personal relationships have been found to be influenced by the built environment, therefore they should be used as intermediate variables between the built environment and SWB, and not as control variables. One study comparing

two high-rise urban neighborhoods with a low-density suburban neighborhood in Chicago finds that life satisfaction is higher in the high-rise neighborhoods (Du, Wood, Ditchman, & Stephens, 2017). Another study examining the relationship between the built environment and SWB focuses on elderly populations in Nanjing, China and includes neighborhoods of diverse densities and also intermediate variables (Feng et al., 2017). Findings from that study suggest that density has nonsignificant effects on satisfaction with health, residence, transport, and social interaction and eventually nonsignificant effects on SWB among elderly populations (Feng et al., 2017). To understand how compactness may influence SWB, further research is needed in this direction: more comparisons between diverse urban forms in the same geographical and cultural context and more in-depth investigations of the role of SWB determinants mediating the relationship between urban form and SWB.

### 3. Data and methods

#### 3.1. Data sources

This study relies on quantitative data from a survey (N = 1344) conducted between May and June 2016 in the metropolitan area of Oslo for the purposes of a research project on urban form and SWB (Mouratidis, 2018b). The survey collected responses from residents of 45 neighborhoods covering diverse locations (inner city, inner suburbs, and outer suburbs) and diverse urban forms (low, medium, and high density). The neighborhoods of the study can be seen in Fig. 1. A full list of the study's neighborhoods and their urban form attributes is included in the Appendix. A random sample selection was performed within the

neighborhoods of the study. Survey participants were 18 years or older and only one person per household received an invitation letter. The invitation letter was sent to the randomly selected residents and included a link to an electronic survey. Most of the sample's socio-demographic attributes do not deviate much from the population but there are some differences (see Table A4 in Appendix). The sample is characterized, on average, by higher age, lower unemployment, higher income, and higher education levels. However, since the main purpose of the study is not to describe the univariate distribution of SWB but to assess its conditional relationship with urban form using multiple regression analysis, any geographical over- or underrepresentation of certain groups of people in the sample would not be expected to materially affect the results (Crano, Brewer, & Lac, 2015). The study's sample is large enough to include diverse groups of people, and multiple regression analysis used in the study controls for a range of socio-demographic variables, including age, unemployment, income, and education level, thereby capturing the relationships between urban form and SWB from all groups of people represented in the sample.

#### 3.2. Conceptual model and variable descriptions

Fig. 2 presents the conceptual model of this study as adapted from the conceptual framework by Mouratidis (2018c). Descriptive statistics for all variables are shown in Table 1. SWB was measured following the state-of-the-art guidelines of OECD (2013) and the European Social Survey (2012). Life satisfaction was measured by asking participants to evaluate how satisfied they are with their lives as a whole nowadays on a scale from “extremely dissatisfied” (0) to “extremely satisfied” (10). On the same scale, eudaimonia was measured by asking to what extent

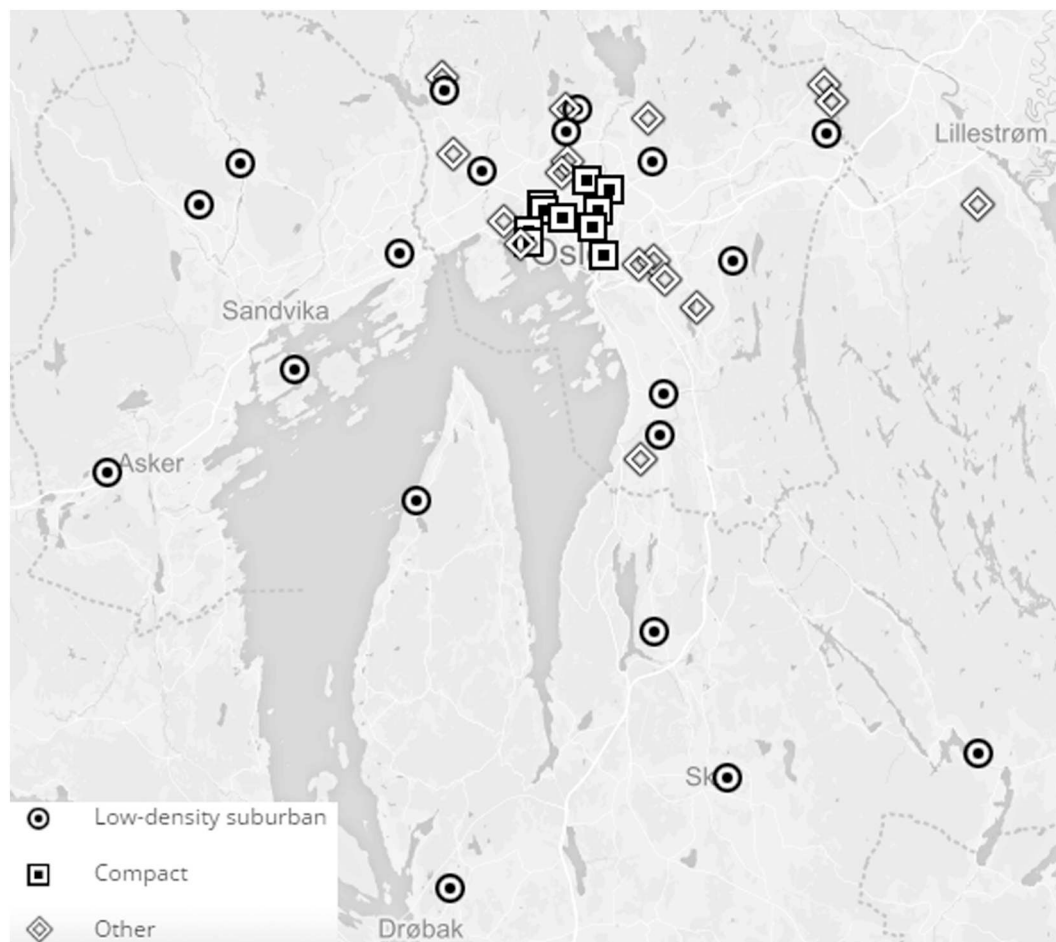


Fig. 1. Selected neighborhoods within the metropolitan area of Oslo.

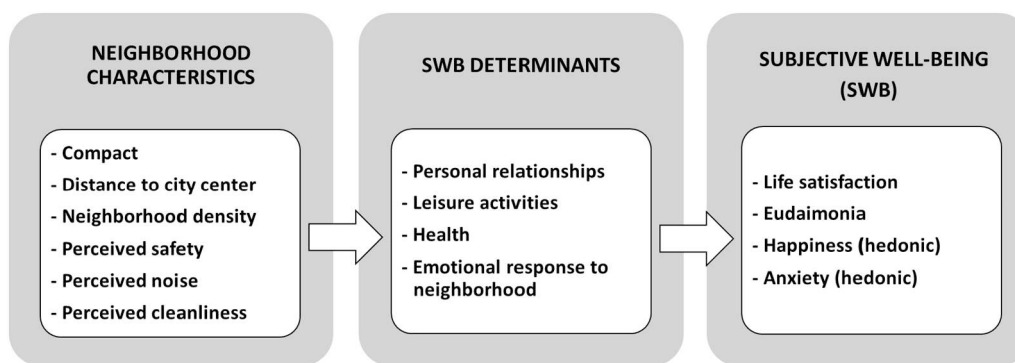


Fig. 2. Conceptual model adapted from Mouratidis (2018c).

Table 1  
Descriptive statistics of all variables.

Variables	N	Min/max	Mean	s.d.
<i>SWB</i>				
Life satisfaction	1340	0/10	7.88	(1.71)
Eudaimonia	1329	0/10	7.85	(1.70)
Happiness (hedonic)	1318	1/5	3.67	(0.84)
Anxiety (hedonic)	1324	1/5	2.02	(1.01)
<i>SWB determinants</i>				
Personal relationships satisfaction	1315	0/10	7.57	(1.91)
Leisure satisfaction	1309	0/10	7.15	(2.09)
Health	1338	0/10	7.72	(1.82)
Emotional response to neighborhood	1322	1/5	4.11	(0.75)
<i>Neighborhood characteristics</i>				
Compact (low-density suburban = 0, compact = 1)	1039	0/1	0.51	(0.50)
Distance to city center (km)	1344	0.7/46.2	10.22	(10.84)
Neighborhood density (persons/ha)	1341	14/306	112.93	(88.04)
Perceived safety	1330	1/5	4.22	(0.82)
Perceived noise	1341	1/5	2.46	(1.14)
Perceived cleanliness	1325	1/5	3.81	(0.91)
<i>Sociodemographic variables</i>				
Age	1344	19/94	50.16	(15.71)
Unemployed	1339	0/1	0.03	(0.16)
Living with partner/spouse	1329	0/1	0.61	(0.49)
Non-Norwegian	1342	0/1	0.09	(0.28)
Adjusted household income (1000s NOK) <sup>a</sup>	1259	35/4330	642.2	(321.08)
Respondent is female	1331	0/1	0.53	(0.50)
Respondent has college degree or higher	1341	0/1	0.79	(0.41)
Household with children	1334	0/1	0.32	(0.47)

<sup>a</sup> Annual household income divided by the square root of household size.

the participants feel that the things they do in their lives are worthwhile. Hedonic well-being (or emotional well-being or affect) was measured by asking participants to evaluate the frequency of emotions of happiness and anxiety over the past week on a scale from “very rarely or never” (1) to “very often or always” (5).

SWB determinants were also measured on similar scales. Personal relationships satisfaction was measured by asking how satisfied residents are with their personal relationships on a scale from “extremely dissatisfied” (0) to “extremely satisfied” (10). On the same scale, leisure satisfaction was measured by asking residents to evaluate how satisfied they are with the time spent on favorite leisure activities. Health was measured by asking residents to describe their general health on a scale from “extremely poor” (0) to “extremely good” (10). Emotional response to neighborhood was measured by asking residents to describe their feelings experienced when walking or biking within their neighborhood on a scale from “very negative” (1) to “very positive” (5).

Two approaches are used to investigate the role of the urban form in SWB. The first approach employs a dichotomous variable “compact” where 0 is low-density suburban neighborhood and 1 is compact neighborhood. This variable applies to analysis with participants only

from compact and low-density suburban neighborhoods. Sample from other types of urban form is excluded when this variable is used. “Compact neighborhoods” are categorized as those with high population densities, apartment blocks, and mixed commercial and residential land uses. “Low-density suburban neighborhoods” are categorized as those with low population densities, detached housing, and separate land uses. Mean population densities are 211 persons per hectare for compact neighborhoods and 29 persons per hectare for low-density suburban neighborhoods. For details on neighborhoods and their characteristics see the Appendix.

The second approach used to assess the role of the urban form in SWB focuses on specific urban form attributes and is based on sample from all types of urban form (low, medium, and high density). This more sophisticated analytical approach captures statistical effects that may not be captured by the first approach. Two urban form attributes are examined: distance to city center and neighborhood density. Distance to city center was measured from the centroid of each neighborhood in kilometers, along the pedestrian network. Neighborhood density was measured by dividing the population of each neighborhood by the area coverage in hectares.

The three urban problems (fear of crime, noise, and litter) examined in the study were evaluated by survey respondents at a neighborhood level. Neighborhood was defined in the questionnaire as the local area within 15 min’ walking distance from the respondent’s dwelling, to achieve greater consistency among respondents. Respondents were asked to evaluate their neighborhood’s safety, noise, and cleanliness on a scale from “very low” (1) to “very high” (5).

### 3.3. Analysis approach

The study uses multiple linear regression analysis as its main analytical method to present an overview of the relationships between urban form, SWB determinants, and SWB, and make subsequent theoretical reflections. Models on health are examined using a reduced sample, excluding residents living for less than one year in their present dwelling, to allow time for the development of a potential influence of urban form on health. Using structural equation modeling as analytical method has also been explored, but has not been preferred as it employs simultaneous estimation which would not allow the use of a different sample for the health variable. In addition, latent factors, which are one of the main features of structural equation modeling, are not used in this study. SWB was measured based on OECD (2013) guidelines, and the different SWB measures are examined independently, not as latent factors. For all the aforementioned reasons, multiple regression analysis is selected as the most appropriate method to address the research questions of this study.

Based on the conceptual model presented in Fig. 2, the study examines the relationships between three groups of variables. Specifically, it firstly examines associations between SWB determinants and SWB, then between built environment characteristics and SWB

**Table 2**  
Regression models examining the impact of sociodemographic variables on SWB.

Variables	Life satisfaction	Eudaimonia	Happiness (hedonic)	Anxiety (hedonic)
	A	B	C	D
<i>Sociodemographic variables</i>				
Age	−0.603***	0.204***	−0.638***	−0.170***
Age squared	0.769***		0.616***	
Unemployed	−0.163***	−0.146***	−0.090**	0.131***
Living with partner/spouse	0.161***	0.092**	0.141***	0.016
Non-Norwegian	−0.029	0.004	0.027	0.072*
Adjusted household income	0.178***	0.106***	0.111***	−0.126***
Female	0.050 <sup>a</sup>	0.106***	0.055 <sup>a</sup>	0.014
College degree or higher	0.039	0.113***	0.008	−0.042
Household with children	0.018	0.044	−0.004	−0.046
<i>Summary statistics</i>				
N	1221	1214	1206	1210
R-squared	0.148	0.123	0.055	0.079

All coefficients shown are standardized.

<sup>a</sup>  $p < 0.10$

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

determinants, and finally between built environment characteristics and SWB. The coefficients shown in the regression tables are standardized coefficients.

## 4. Results

Sociodemographic variables are used as control variables throughout the study. Table 2 presents the statistical effects of sociodemographics on SWB measures. The results confirm that life satisfaction and happiness are U-shaped with age (Blanchflower & Oswald, 2008, 2011). This means that younger and older individuals are happier than middle-aged individuals, possibly because during mid-life individuals recognize and suppress unachievable life aspirations (Blanchflower & Oswald, 2008). Since there are no theoretical or empirical insights to support a U-shaped pattern of other SWB measures or SWB determinants over the life cycle, age squared is only included in models of life satisfaction and happiness. Results generally indicate that SWB is higher for those who are employed, wealthier, and live with a partner or spouse, as supported by previous research (Blanchflower & Oswald, 2011). Immigrant populations appear to have higher levels of anxiety, and lower life satisfaction as in Liu, Zhang, Wu, Liu, and Li (2017), though the latter is nonsignificant. Interestingly, females exhibit higher levels of SWB. Tertiary education has a significant positive contribution only to eudaimonia. Having children in the household is found to have a modest, but nonsignificant, positive association with eudaimonia and a modest, but nonsignificant, negative association with anxiety.

### 4.1. SWB determinants and SWB

Results in Table 3 include four models, one for each measure of SWB. The models examine four SWB determinants along with sociodemographic variables. As results indicate, the four SWB determinants examined significantly contribute to SWB. Personal relationships satisfaction, leisure satisfaction, and health are all positively associated with life satisfaction, eudaimonia, and happiness, and negatively associated with anxiety. Personal relationships satisfaction has by far the highest statistical effect on life satisfaction, eudaimonia, and happiness, confirming that it is the most influential life domain of SWB (Diener & Seligman, 2002; Vaillant, 2012). Health has the strongest association with anxiety. Emotional response to neighborhood has smaller but still significant positive effects on life satisfaction

and happiness, while it has nonsignificant effects on eudaimonia and anxiety.

### 4.2. Urban form and SWB determinants

Table 4 presents the regression results examining the statistical effects of urban form characteristics on the four relevant SWB determinants. Model C includes only residents living for one year or longer in their present dwelling, so that there is sufficient time for a potential impact of the urban form on health. Results in Table 4 suggest that compared with low-density suburban forms, compact urban forms are associated with significantly higher personal relationships satisfaction and higher perceived health, but also with significantly more negative emotional response to neighborhood. The statistical effect of compactness on leisure satisfaction is nonsignificant. In particular, the results suggest that shorter distances to city center, which are enabled by higher overall density of the city, facilitate higher personal relationships satisfaction and higher perceived health. On the other hand, in the case of emotional response to neighborhood, it is the high local neighborhood density that induces negative emotions, while the short distances to city center induce positive emotions but these are less strong in comparison to the negative ones induced by neighborhood density.

Table 5 examines urban form characteristics along with three perceived variables related to common problems in dense urbanized areas. This analysis attempts to estimate whether the influence of urban form on SWB determinants changes if these problems are mitigated. Models A and B do not include noise and cleanliness, as there is no theoretical reason explaining why these could influence personal relationships and leisure. Results in Table 5 indicate that when common urban problems are controlled for, the effect of compactness becomes more positive. The significant positive effects of compactness on personal relationships satisfaction and perceived health become even stronger. The emotional response to compact neighborhoods changes from significantly negative to significantly positive. The association between urban form and leisure satisfaction still remains nonsignificant. Results suggest that perceived safety in particular is very influential in SWB as it exhibits the strongest and most significant effects on relevant SWB determinants. With specific regard to emotional response to neighborhood, all perceived variables exhibit significant effects. Perceived safety and cleanliness have positive effects, while noise has a negative, and less strong, effect.

**Table 3**  
Regression models examining the impact of SWB determinants on SWB.

Variables	Life satisfaction		Eudaimonia		Happiness (hedonic)		Anxiety (hedonic)	
	A		B		C		D	
<i>SWB determinants</i>								
Personal relationships satisfaction	0.402***		0.405***		0.340***		−0.138***	
Leisure satisfaction	0.164***		0.149***		0.123***		−0.069*	
Health	0.217***		0.189***		0.112***		−0.184***	
Emotional response to neighborhood	0.053*		0.027		0.072**		−0.038	
<i>Sociodemographic variables</i>								
Age	−0.289 <sup>a</sup>		0.202**		−0.545**		−0.176**	
Age squared	0.423**				0.502**			
Unemployed	−0.088**		−0.068**		−0.031		0.100***	
Living with partner/spouse	0.117***		0.046 <sup>a</sup>		0.090***		0.046	
Non-Norwegian	−0.044*		−0.016		0.019		0.095***	
Adjusted household income	0.080***		0.026		0.044		−0.085**	
Female	−0.017		0.046*		−0.009		0.046 <sup>a</sup>	
College degree or higher	−0.009		0.080***		−0.028		−0.006	
Household with children	0.030		0.079***		0.012		−0.058*	
<i>Summary statistics</i>								
N	1164		1160		1149		1154	
R-squared	0.506		0.453		0.269		0.175	

All coefficients shown are standardized.

<sup>a</sup>  $p < 0.10$ .

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

**Table 4**  
Regression models examining the impact of urban form on SWB determinants.

Variables	Personal relationships satisfaction		Leisure satisfaction		Health		Emotional response to neighborhood	
	A1	A2	B1	B2	C1	C2	D1	D2
<i>Urban form attributes</i>								
Compact	0.090*		−0.043		0.083*		−0.103**	
Distance to city center		−0.117**		0.001		−0.081*		−0.065 <sup>a</sup>
Neighborhood density		−0.028		−0.061		−0.007		−0.169***
<i>Sociodemographic variables</i>								
Age	0.077*	0.056 <sup>a</sup>	0.131***	0.090**	−0.034	−0.055	0.080*	0.071*
Unemployed	−0.144***	−0.142***	−0.055 <sup>a</sup>	−0.048	−0.045	−0.062*	−0.005	−0.001
Living with partner/spouse	0.133***	0.135***	−0.023	−0.004	0.013	0.009	0.058 <sup>a</sup>	0.066*
Non-Norwegian	0.010	−0.006	0.053	0.038	0.092**	0.075*	−0.039	−0.033
Adjusted household income	0.109**	0.097***	0.079*	0.067*	0.144***	0.137***	0.075*	0.087**
Female	0.140***	0.155***	0.010	0.009	−0.012	−0.005	0.086**	0.098***
College degree or higher	0.009	0.007	−0.016	0.013	0.158***	0.118*	0.036	0.076**
Household with children	−0.022	−0.050	−0.086*	−0.126**	0.049	0.027	0.101**	0.077*
<i>Summary statistics</i>								
N	930	1203	918	1190	848	1105	936	1209
R-squared	0.085	0.094	0.047	0.042	0.079	0.067	0.066	0.079

All coefficients shown are standardized.

Sample for Model C includes solely residents living for one or more years in their present dwelling.

<sup>a</sup>  $p < 0.10$ .

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

### 4.3. Urban form and SWB

Table 6 examines associations between urban form characteristics and four measures of SWB. Results indicate that urban form compactness is not significantly associated with life satisfaction, eudaimonia, and happiness. Yet, it is associated with higher anxiety (marginally significant  $p = 0.101$ ). This means that residents of compact neighborhoods seem to have higher levels of anxiety.

Table 7 examines urban form characteristics along with the three variables related to common urban problems. This analysis attempts to estimate whether the influence of urban form on SWB changes if these

problems are mitigated. Similar to the previous analysis on SWB determinants, the statistical effects of compactness on measures of SWB are found to become more positive when perceived safety, cleanliness, and noise are included. Particularly, the nonsignificant positive association between compactness and life satisfaction now becomes significant. And the significant negative association between compactness and anxiety now becomes nonsignificant. In other words, when controlling for urban problems, residents living in compact areas exhibit higher life satisfaction and similar levels of anxiety compared with residents of low-density suburbs. Among the three attributes related to urban problems, perceived safety has the most substantial contribution

**Table 5**  
Regression models examining the impact of urban form and common urban problems on SWB determinants.

Variables	Personal relationships satisfaction		Leisure satisfaction		Health		Emotional response to neighborhood	
	A1	A2	B1	B2	C1	C2	D1	D2
<i>Urban form attributes</i>								
Compact	0.154***		0.005		0.141**		0.079*	
Distance to city center		-0.121**		0.000		-0.071 <sup>a</sup>		-0.068*
Neighborhood density		0.017		-0.016		0.055		-0.017
<i>Common urban problems</i>								
Perceived safety	0.182***	0.155***	0.148***	0.165***	0.190***	0.159***	0.234***	0.244***
Perceived noise					-0.080*	-0.058 <sup>a</sup>	-0.053	-0.072*
Perceived cleanliness					-0.062	-0.016	0.217***	0.199***
<i>Sociodemographic variables</i>								
Age	0.075*	0.052 <sup>a</sup>	0.130***	0.087**	-0.046	-0.065 <sup>a</sup>	0.095**	0.076**
Unemployed	-0.141***	-0.142***	-0.051	-0.047	-0.044	-0.063*	0.002	0.001
Living with partner/spouse	0.128***	0.127***	-0.026	-0.012	0.009	0.002	0.063*	0.061*
Non-Norwegian	0.006	-0.010	0.049	0.033	0.087**	0.073*	-0.038	-0.033
Adjusted household income	0.097**	0.086**	0.070*	0.055 <sup>a</sup>	0.127***	0.123***	0.047	0.049 <sup>a</sup>
Female	0.137***	0.150***	0.009	0.005	-0.032	-0.022	0.078**	0.083**
College degree or higher	-0.003	-0.007	-0.024	0.000	0.150***	0.103***	0.011	0.043
Household with children	-0.012	-0.044	-0.080*	-0.122***	0.043	0.023	0.120***	0.092**
<i>Summary statistics</i>								
N	922	1191	910	1178	831	1080	917	1181
R-squared	0.114	0.115	0.066	0.067	0.114	0.093	0.218	0.235

All coefficients shown are standardized.

Sample for Model C includes solely residents living for one or more years in their present dwelling.

<sup>a</sup>  $p < 0.10$ .

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

to life satisfaction and eudaimonia, while perceived safety and noise make important contributions to the hedonic measures of happiness and anxiety.

### 5. Discussion

The results of this paper suggest that compactness of the urban form

contributes to SWB determinants in different ways. Compact urban forms seem to positively influence the two most important relevant determinants of SWB: personal relationships and health. Higher levels of personal relationships satisfaction in compact areas have been attributed to a higher concentration of people, easier access to other areas, and more facilities for socializing which altogether enable larger social networks and more active social life (Mouratidis, 2018a). The

**Table 6**  
Regression models examining the impact of urban form on SWB.

Variables	Life satisfaction		Eudaimonia		Happiness (hedonic)		Anxiety (hedonic)	
	A1	A2	B1	B2	C1	C2	D1	D2
<i>Urban form attributes</i>								
Compact	0.009		-0.012		-0.025		0.062 <sup>b</sup>	
Distance to city center		-0.026		0.011		0.018		-0.047
Neighborhood density		-0.027		-0.008		-0.033		0.020
<i>Sociodemographic variables</i>								
Age	-0.851***	-0.558**	0.229***	0.197***	-0.726**	-0.665***	-0.169***	-0.148***
Age squared	1.037***	0.753***			0.744***	0.626**		
Unemployed	-0.160***	-0.163***	-0.140***	-0.146***	-0.092**	-0.091**	0.120***	0.132***
Living with partner/spouse	0.153***	0.162***	0.082*	0.093**	0.118***	0.135***	0.045	0.021
Non-Norwegian	-0.019	-0.028	0.024	0.005	0.039	0.028	0.055 <sup>a</sup>	0.071*
Adjusted household income	0.210***	0.177***	0.113***	0.107***	0.140***	0.112***	-0.142***	-0.126***
Female	0.047	0.051 <sup>a</sup>	0.093**	0.107***	0.059 <sup>a</sup>	0.056 <sup>a</sup>	0.010	0.013
College degree or higher	0.055 <sup>a</sup>	0.037	0.109***	0.115***	0.013	0.012	-0.054 <sup>a</sup>	-0.048 <sup>a</sup>
Household with children	0.039	0.014	0.060 <sup>a</sup>	0.039	0.016	-0.015	-0.067 <sup>a</sup>	-0.033
<i>Summary statistics</i>								
N	941	1218	936	1211	993	1203	932	1207
R-squared	0.170	0.150	0.135	0.124	0.063	0.057	0.092	0.083

All coefficients shown are standardized.

<sup>a</sup>  $p < 0.10$ .

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

<sup>b</sup>  $p = 0.101$ .

**Table 7**  
Regression models examining the impact of urban form and common urban problems on SWB.

Variables	Life satisfaction		Eudaimonia		Happiness (hedonic)		Anxiety (hedonic)	
	A1	A2	B1	B2	C1	C2	D1	D2
<i>Urban form attributes</i>								
Compact	0.082 <sup>a</sup>		0.060		0.040		0.015	
Distance to city center		−0.033		0.002		0.006		−0.042
Neighborhood density		0.038		0.052		0.014		−0.029
<i>Common urban problems</i>								
Perceived safety	0.151***	0.133***	0.138***	0.122***	0.091 <sup>a</sup>	0.082 <sup>a</sup>	−0.137***	−0.090**
Perceived noise	−0.034	−0.041	−0.060 <sup>a</sup>	−0.058 <sup>a</sup>	−0.082 <sup>a</sup>	−0.076 <sup>a</sup>	0.081 <sup>a</sup>	0.094**
Perceived cleanliness	0.019	0.045	−0.001	0.033	−0.001	0.002	0.095 <sup>a</sup>	0.039
<i>Sociodemographic variables</i>								
Age	−0.791***	−0.538**	0.224***	0.192***	−0.658**	−0.606**	−0.170***	−0.150***
Age squared	0.970***	0.695***			0.668**	0.563**		
Unemployed	−0.158***	−0.162***	−0.137***	−0.144***	−0.092**	−0.091**	0.120***	0.131***
Living with partner/spouse	0.157***	0.159***	0.088**	0.091**	0.122***	0.130***	0.042	0.026
Non-Norwegian	−0.022	−0.029	0.015	−0.002	0.032	0.022	0.069 <sup>a</sup>	0.080**
Adjusted household income	0.191***	0.162***	0.097**	0.092**	0.124***	0.104***	−0.130***	−0.127***
Female	0.034	0.038	0.083**	0.097**	0.052	0.046	0.020	0.021
College degree or higher	0.049	0.025	0.105***	0.105***	0.005	−0.005	−0.047	−0.037
Household with children	0.044	0.017	0.067 <sup>a</sup>	0.044	0.019	−0.004	−0.069	−0.044
<i>Summary statistics</i>								
N	922	1190	917	1183	914	1176	913	1179
R-squared	0.195	0.178	0.159	0.151	0.078	0.071	0.115	0.105

All coefficients shown are standardized.

<sup>a</sup>  $p < 0.10$ .

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

higher self-reported health found in compact areas is in accordance with some previous studies (Stevenson et al., 2016; Sturm & Cohen, 2004) and could be explained by higher levels of walking and cycling and reduced usage of private vehicles (Ewing et al., 2003; Stevenson et al., 2016). On the other hand, emotional response to neighborhood seems to be negatively influenced by compactness and especially by higher local densities as these may induce higher fear of crime, noise, and litter. These attributes may contribute to negative emotions such as feeling stressed, upset, afraid or threatened. An additional explanation of the more negative emotional response to compactness could be the lower connection with nature and stronger feelings of overcrowding, when compared with less compact, suburban settings. Nature has important perceived restorative properties (Carrus et al., 2015) which can induce positive emotions of calmness and relaxation, while overcrowding can induce negative stressful emotions. Finally, leisure satisfaction does not appear to be significantly influenced by compactness. Compactness may possibly influence leisure in both positive and negative ways that counteract each other leading to a nonsignificant total effect. Overall, residents of different urban forms are found to be similarly satisfied with the time spent on favorite leisure activities.

Furthermore, results suggest that compactness is not significantly associated with three SWB measures, life satisfaction, eudaimonia, and happiness, but is associated with higher anxiety. The finding that residents of low-density suburban neighborhoods and residents of high density urban neighborhoods have similar levels of life satisfaction and happiness is in line with results by Feng et al. (2017), although that study focuses only on elderly populations. This finding of the present study contradicts previous suggestions that high density (as typical for the centrally located neighborhoods in this study) is detrimental to livability (Churchman, 1999; Neuman, 2005; Simmel, 1903). It is also in disagreement with regional studies suggesting that high densities may lead to unhappiness (e.g. Morrison, 2011). This claim might be valid when comparing different regions within a country, but is not necessarily applicable to densities within a specific city region. Results from the present study suggest that within a certain city region, higher

densities do not seem to lead to lower life satisfaction or to unhappiness. In certain cases, they are indeed associated with higher life satisfaction (Du et al., 2017). Increased anxiety found in high-density areas is consistent with the findings by Lederbogen et al. (2011) and supports the ideas that higher noise increases stress levels (WHO, 2011) and that lower perceptions of safety can negatively influence mental health (Won, Lee, Forjuoh, & Ory, 2016). In addition to higher noise and lower perceived safety, the less natural environment, plethora of stimuli, intense life rhythms, and impersonal local interactions in dense urban areas could increase levels of anxiety and stress. In accordance with these considerations, the higher anxiety revealed in compact areas could be connected to the more negative emotional response to compactness found in the present study. However, the insignificant statistical effect of emotional response to neighborhood on anxiety (Table 3) indicates that the higher anxiety in compact areas might also be attributed to the personal characteristics of residents that choose to live in such areas.

There is an evident paradox in the findings of this paper. Although compactness has positive associations with the two most important SWB determinants, personal relationships and health, it does not exhibit significant positive associations with life satisfaction, eudaimonia, and happiness as one would expect, but instead yields insignificant ones. This paradox is also highlighted by the fact that although neighborhood satisfaction, which is a predictor of life satisfaction, has been found to be significantly higher in compact areas of Oslo (Mouratidis, 2017), this is not translated into higher life satisfaction. Therefore, there seem to be other indirect negative effects in existence which cancel out the possible positive effects of compactness on SWB through personal relationships and health.

(1) The most evident of these is emotional response to neighborhood, which is lower for compact urban forms. (2) Another indirect negative effect is that of anxiety. Compactness is found to be associated with increased anxiety. Anxiety is negatively associated with the other measures of SWB, life satisfaction, eudaimonia, and happiness. Thus, a potential increase in anxiety cancels out some part of the benefits



arising from increased personal relationships satisfaction and health. Nonetheless, the combined negative indirect effects of compactness through emotional response to neighborhood and anxiety on life satisfaction, eudaimonia, and happiness are significantly less strong than the positive ones through personal relationships satisfaction and health. For example, personal relationships satisfaction has a much stronger influence on life satisfaction compared with emotional response to neighborhood (as seen in Table 3). At the same time, health is more strongly correlated with life satisfaction than anxiety is ( $r = 0.45$  versus  $r = -0.38$ ). Therefore, it seems that the impacts of emotional response to neighborhood and anxiety alone are not enough to counterbalance the contribution of increased personal relationships satisfaction and health to the three SWB measures (life satisfaction, eudaimonia, and happiness). (3) There might be an additional underlying factor counterbalancing the positive impact of compactness on SWB through personal relationships and health. One hypothesis is that this factor could be related to the characteristics of the people living in denser urban areas. There is evidence suggesting that personality traits and human values differ across geographical locations, thus influencing SWB (Ballas & Tranmer, 2012; Jokela, Bleidorn, Lamb, Gosling, & Rentfrow, 2015; Morrison & Weckroth, 2017). If there are certain personality traits or human values that negatively influence SWB, and if these are more prominent in compact areas, then the question is whether the urban form plays any role in that. In other words, there is not enough knowledge on whether a compact urban environment can cultivate certain personality traits and human values, or whether it is people with certain personalities and values who choose to live in compact areas. Another hypothesis is that there might be some relevant SWB determinant influenced by urban form that is not considered in the conceptual framework applied here, or that is not completely captured by the survey questions on the four life domains. One example could be the feelings of connection with nature, which can have a positive impact on SWB (Carrus et al., 2015; MacKerron & Mourato, 2013; Raanaas, Patil, & Hartig, 2012; White, Alcock, Wheeler, & Depledge, 2013) and might not be completely captured by the question on emotional response to neighborhood. All these are just hypotheses however and should be further investigated in future research.

Another issue that arises from the findings of this paper is the relationship between the concepts of anxiety, perceived health, and SWB. First, anxiety can be a measure of both health and the hedonic well-being component of SWB. In this paper, it has been used as a measure of SWB as per OECD's guidelines on SWB measurement (OECD, 2013). It could have been alternatively used as a life domain item related to health, and specifically related to mental health. The evident question that emerges is: what aspects of health are covered by the "perceived health" item of the survey? Although the survey item asked residents to evaluate their health in general, the quantitative results of the paper imply that residents specifically evaluated their physical health when completing this survey item. The finding that perceived health is higher in compact areas while anxiety is also higher in compact areas suggests that the two measures are largely distinct. Their Pearson correlation coefficient shows that the two measures are indeed distinct ( $r = -0.25$ ), even when considering that the correlation between anxiety and life satisfaction which are certainly distinct measures is stronger ( $r = -0.38$ ). Moreover, it is theoretically justifiable and in line with several previous research studies that physical health, measured here as perceived health, can be enhanced in compact areas due to more active everyday travel (Stevenson et al., 2016; Sturm & Cohen, 2004), while anxiety can also be higher (Lederbogen et al., 2011; Peen, Schoevers, Beekman, & Dekker, 2010) possibly due to environmental stressors and/or residents' personal characteristics (e.g. personality, human values) in denser urban areas.

After statistically controlling for variables relevant to common problems in dense urban areas (safety, cleanliness, and noise), both SWB determinants and SWB measures improve for denser areas. Positive associations between compactness and personal relationships

satisfaction as well as perceived physical health become even stronger. The significantly negative association between compactness and emotional response to neighborhood becomes significantly positive. The significant negative association between compactness and anxiety becomes nonsignificant. Altogether, these lead to a significant positive association between compactness and life satisfaction. In accordance with previous studies (Ettema & Schekkerman, 2016; WHO, 2011), especially safety and noise seem to be crucial when examining the role of compact urban form in SWB. Thus, to plan for livable compact cities, which could be a strategy towards both environmental and social sustainability, common urban problems such as fear of crime and high noise levels should certainly be addressed by policymakers.

To expand the relevance of this paper's findings to a wider set of contexts, we should consider the characteristics of the built environment in Oslo as well as the socioeconomic characteristics of its population. Both Oslo's inner city as well as its suburbs are of relatively high quality. There is an extensive multimodal public transport system, which allows car restrictions within the city, resulting in limited traffic and noise even in the denser areas. There is also easy access to green spaces – which have been found to promote SWB (Carrus et al., 2015; Dong & Qin, 2017) – with parks in every neighborhood and close proximity to the forest. Although the inner city is characterized by high density (average density of the study's compact areas is 211 persons per hectare), this density is not extremely high by world standards. Therefore, even central compact areas are not too overcrowded, which could lead to higher stress levels and discomfort (Churchman, 1999). Crime rates are low in Oslo. In addition, due to the country's welfare system, social equity, which plays an important role in happiness in cities (Ballas, 2013), is high both between as well as within neighborhoods. There are no significant cases of highly degraded urban or suburban areas. Specifically for the study's case neighborhoods, median incomes are almost identical in the inner city and the suburbs. Therefore, overall, Oslo is a relatively well-functioning, peaceful, green, and prosperous city of high social equity. Along the lines of the present study's findings, we could expect urban form to influence SWB in similar ways in major metropolitan areas of other Nordic countries and perhaps even in cities with similar physical form and socioeconomic attributes in other geographical contexts. In contrast, compact areas of cities that face major urban problems such as overcrowding due to extremely high densities, extreme traffic and noise, poverty, high crime levels, litter, and lack of green space might produce different results. In such cases for example, health might be negatively influenced because of high pollution and stress, certain leisure activities might be restricted due to lack of green space, and emotional response to neighborhood might be more negative. Similarly, cases of degraded suburbs that face problems such as very low access to facilities, poor connection to other areas by public transport, poverty, and high crime levels might also negatively influence SWB determinants and eventually SWB. As other cities may differ from Oslo in terms of physical form or socioeconomic characteristics, future studies should continue to explore the relationship between urban form and SWB in various cities in order to provide insights from a wider set of contexts.

There are a few limitations in this study. First, although the conceptual framework used has been successfully applied, since the four SWB determinants employed as mediators are indeed found to be associated with both built environment characteristics as well as SWB measures, there may be additional latent SWB determinants that are relevant to the built environment and are not considered here. Second, personal characteristics such as human values and personality traits that could perhaps offer further explanations of the study's findings are not included in the analysis. Third, although the study presents to a certain degree evidence on causality due to its conceptual framework and the inclusion of intermediate variables, regression results are cross-sectional and should be interpreted with caution since they indicate associations but not necessarily causal relationships. Fourth, the study examines urban form compactness by focusing on local neighborhood

density and residential distance to city center (higher city compactness – shorter distances). It does not focus on other built environment attributes which can be influenced by urban form density such as transport, land use mix, and local facilities. Fifth, survey data used in this study offer only univariate measures of perceived neighborhood attributes, life domains, and SWB, whereas latent constructs could have produced more reliable estimations. Finally, the study's main contribution is presenting new empirical evidence which serves as an overview of the relationships between urban form, life domains, and SWB. It is not within the scope of this study to examine interrelationships between built environment attributes, between life domains, and between SWB measures, which could be done in the future using structural equation modeling. Future research could build upon this study and explore this topic further by addressing the aforementioned issues while using panel data and more sophisticated analytical methods such as multilevel modeling or structural equation modeling.

## 6. Conclusions

This paper provides new empirical insights into the impact of compact (high density, mixed land uses, and high public transport accessibility) versus sprawled (lower densities, separate land uses, and higher car reliance) urban forms on SWB. Although compact cities have often been considered as having adverse social effects (Churchman, 1999; Morrison, 2011; Simmel, 1903; Wirth, 1938), previous literature has not adequately examined the relationships between diverse urban forms and SWB within the same city region. The paper's findings suggest that compact development is not necessarily detrimental to SWB when high densities are accompanied by mixed land uses, public transport, limited car traffic, access to green spaces, and social equity. Moreover, it seems that if urban problems related to fear of crime, litter, and noise are mitigated, the compact city has the potential to promote SWB.

A further contribution of this paper is that as well as seeking to

assess possible impacts of the urban form on SWB, it additionally sheds light on how these impacts are shaped. Empirical investigations explaining how causal relationships between the built environment and SWB are shaped are scarce. This study has applied a new conceptual and methodological framework (Mouratidis, 2018c) that includes SWB determinants – personal relationships satisfaction, health, leisure satisfaction, and emotional response to neighborhood – as mediating variables that help explain causal mechanisms. Thereby, this study moves beyond dominant research approaches that focus solely on correlations between environmental attributes and SWB or use neighborhood/community satisfaction as an intermediate variable between environmental attributes and SWB (see e.g. Marans, 2003). The approach followed here provides a new paradigm for future relevant research.

The study's findings indicate positive signs for urban sustainability. Important synergies between environmental and social sustainability have been identified. It is of particular significance that environmentally friendly urban forms can be beneficial for personal relationships and physical health. These are not only among the most crucial domains for quality of life at a certain point in time, but are very important for human flourishing across the lifespan (e.g. Vaillant, 2012). On the other hand, the study's findings suggest that special attention should be paid to perceived safety and noise. Fear of crime and noise appear to be concerns even in relatively peaceful and quiet compact cities and may lead to unpleasant emotions and increased anxiety. Researchers, practitioners, and policymakers should look carefully into ways to counter these implications in order to achieve the goal of livable compact cities.

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## Appendix

Table A1

Compact neighborhoods of the study.

Neighborhood name	Neighborhood type	Population density (persons/ha)	Distance to city center (km)	Main building type	Land uses	Sample size (persons)
St. Hanshaugen	Compact	203	2.3	Apartment block	Mixed	62
Grønland	Compact	205	1.0	Apartment block	Mixed	100
Frogner A	Compact	135	2.8	Apartment block	Mixed	8
Frogner B	Compact	306	2.6	Apartment block	Mixed	20
Majorstuen A	Compact	221	3.1	Apartment block	Mixed	57
Majorstuen B	Compact	247	2.9	Apartment block	Mixed	35
Sagene	Compact	267	3.5	Apartment block	Mixed	57
Torshov	Compact	135	3.3	Apartment block	Mixed	71
Grünerløkka A	Compact	171	1.5	Apartment block	Mixed	53
Grünerløkka B	Compact	244	2.3	Apartment block	Mixed	72

Note: Total sample size for compact neighborhoods N = 535.

Table A2

Low-density suburban neighborhoods of the study.

Neighborhood name	Neighborhood type	Population density (persons/ha)	Distance to city center (km)	Main building type	Land uses	Sample size (persons)
Holmen	Low-density suburban	30	6.0	Detached house	Separate	13
Lofthus	Low-density suburban	50	5.6	Detached house	Separate	17
Hellerud	Low-density suburban	44	7.7	Detached house	Separate	33
Holmenkollen A	Low-density suburban	24	10.5	Detached house	Separate	19
Korsvoll	Low-density suburban	31	6.5	Detached house	Separate	11
Nordberg	Low-density suburban	26	5.8	Detached house	Separate	13
Stovner	Low-density suburban	36	13.1	Detached house	Separate	7
Nordstrand	Low-density suburban	38	8.4	Detached house	Separate	14
Hauketo	Low-density suburban	32	10.1	Detached house	Separate	12

(continued on next page)

Table A2 (continued)

Neighborhood name	Neighborhood type	Population density (persons/ha)	Distance to city center (km)	Main building type	Land uses	Sample size (persons)
Rykkinn	Low-density suburban	26	19.2	Detached house	Separate	44
Bærums Verk	Low-density suburban	42	17.7	Detached house	Separate	38
Stabekk	Low-density suburban	26	8.6	Detached house	Separate	11
Asker	Low-density suburban	23	25.0	Detached house	Separate	41
Nesøya	Low-density suburban	14	21.6	Detached house	Separate	45
Ski	Low-density suburban	22	26.4	Detached house	Separate	42
Oppegård	Low-density suburban	27	17.6	Detached house	Separate	51
Drøbak	Low-density suburban	38	36.0	Detached house	Separate	26
Bjørnemyr	Low-density suburban	26	46.0	Detached house	Separate	35
Ytre Enebakk	Low-density suburban	22	32.6	Detached house	Separate	32

Note: Total sample size for low-density suburban neighborhoods N = 504.

Table A3

Other neighborhoods of the study.

Neighborhood name	Neighborhood type	Population density (persons/ha)	Distance to city center (km)	Main building type	Land uses	Sample size (persons)
Frogner C	Inner-city mixed	94	2.8	Mixed	Mostly separate	17
Skøyen	Inner-city low density	46	4.2	Mixed	Separate	16
Grefsen	Suburban mixed	97	7.6	Mixed	Separate	26
Vålerenga	Inner-city mixed	130	2.5	Mixed	Mostly separate	52
Etterstad	Inner-city medium density	72	3.2	Apartment block	Separate	14
Høyenhall	Inner-city low density	52	4.4	Detached house	Separate	13
Østenjø	Suburban mixed	55	6.4	Mixed	Separate	16
Holmenkollen B	Suburban mixed	60	10.6	Mixed	Separate	20
Hovseter	Suburban mixed	76	7.4	Mixed	Separate	22
Ullevål	Inner-city mixed	57	4.0	Mixed	Separate	22
Berg	Inner-city low density	35	4.6	Detached house	Separate	20
Kringsjå	Suburban mixed	73	6.8	Mixed	Separate	12
Vestli	Suburban medium density	126	13.6	Apartment block	Separate	3
Tokerud	Suburban mixed	81	13.8	Mixed	Separate	16
Holmlia	Suburban mixed	62	10.8	Mixed	Separate	13
Blystadlia	Suburban mixed	88	20.0	Mixed	Separate	23

Note: Total sample size for other types of neighborhoods N = 305.

Table A4

Comparison of sociodemographic characteristics.

Sources: Statistics Norway (2017) and European Commission (2016).

Sociodemographic variables	Survey respondents (N = 1344)	Population
	Mean	Mean
Age (for aged 18 or older) <sup>a</sup>	50.16	46.30
Unemployed <sup>b</sup>	2.50%	3.50%
Living with partner/spouse <sup>a</sup>	61%	48%
Non-Norwegian <sup>a</sup>	9%	21%
Adjusted household income (1000s NO-K) <sup>a</sup>	642.2	582.98
Household size (persons) <sup>a</sup>	2.22	1.94
Number of children in household <sup>a</sup>	0.54	0.46
Household with children <sup>a</sup>	32%	26%
Respondent is female <sup>a</sup>	53.40%	50.30%
Respondent has college degree or higher <sup>b</sup>	79%	47%

<sup>a</sup> Population mean refers to the counties of Oslo and Akershus.

<sup>b</sup> Population mean refers to Oslo municipality.

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