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Systematic review of the association between commuting, subjective wellbeing and mental health

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ABSTRACT

Commuting as a habitual routine in people's daily lives is possibly related to subjective wellbeing (SWB) and mental health (MH). However, findings on the commuting–SWB–MH interplay are inconclusive, and a systematic synthesis of the available evidence is lacking.

We therefore systematically reviewed the existing literature on the associations between commuting, SWB and MH. We searched seven databases for eligible English-language publications up to 9 February 2020. We summarized the study specifics in accordance with the PRISMA guideline and assessed the quality of the studies.

In total, 45 studies were eligible for inclusion. We found that objective commute characteristics, such as duration and mode, affected experiential aspects of SWB and MH, but also general MH and cognitive wellbeing. External travel circumstances, like crowdedness and weather conditions, had no structural impacts on the experiential indicators of SWB and MH. Travel attitude and personality traits had effects on long-term cognitive wellbeing as well as domain satisfaction and mental state. Adverse effects of commuting negatively spill-over to home and job. Our results also reveal that the accumulation of commute experiences may change both overall wellbeing and MH, where emotional response seems to act as a moderator.

The effects of commuting on MH and the correlations between different dimensions of MH and SWB are as yet unclear. Advances towards intensive longitudinal rather than cross-sectional study designs including ambulatory physiological measurements through global positioning system-enabled wearables seem critical to better understand the causal pathways along which commuting affects both short- and long-term SWB and MH directly and indirectly.

1. Introduction

Subjective wellbeing (SWB) and mental health (MH) are central to people's overall health (ONS, 2012; Stiglitz et al., 2009). Wellbeing is also on top of policy agendas in many countries (Bache et al., 2013; Delbosc, 2012; United Nations, 2015).

There is growing evidence that travel affects peoples' SWB (Avila-Palencia et al., 2018; Delbosc, 2012; Ettema et al, 2010a) and is related to concepts such as life satisfaction (Friman et al., 2017a), happiness (Ettema et al., 2010b) and life quality (Haslauer et al., 2015).

Commuting is a habitual transport-related routine (van de Coevering and Schwanen, 2006), and commuting duration is increasing. For example, in 2009, workers in the southeast of the UK spent, on average, 31 more hours on commuting than they did in 2008 (TUC, 2019). Commuting thus takes up a significant share of peoples' daily lives, reducing the time available for other social activities (Mattisson et al., 2015).

Commuting is likely to affect SWB in multiple ways (Koslowsky et al., 2013; Redmond and Mokhtarian, 2001), related to trip-specific and person-level characteristics (de Kruijf et al., 2019; Ettema et al., 2012; Ettema et al., 2010b; Mouratidis et al., 2019). It may affect both affective as well as cognitive SWB, and both momentary and long-term manifestations of SWB (Chatterjee et al., 2020; Delbosc, 2012). For example, aspects of individual commuting trips (e.g. time or crowdedness) influence people's short-term affective responses, which, in turn, contributes to their overall, long-term SWB (Mokhtarian, 2019; Ettema et al., 2010a; Clark et al., 2019). In general, commuting relates to SWB mainly through people's direct experiences and accumulated effects on SWB, enabling out-of-home activity participation, and spill-over effects into other domains of well-being (Ettema et al., 2010a; Mokhtarian, 2019; De Vos et al., 2013; Chatterjee et al., 2020; De Vos and Witlox, 2017). Compared to men, women appear more sensitive to commuting

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and suffer more from health problems as a result of commuting (i.e. sickness absence and psychological stress) (Costa et al., 1988). Others also showed that the built environment (e.g. land-use diversity and street connectivity) is both directly and indirectly linked with people's SWB through their travel behaviour (De Vos et al., 2019; Dias et al., 2019; Knez et al., 2018).

MH is also shaped by the commuting experience (Marmot, 2005). For example, Wang et al. (2019) found that commuting duration and delay time were positively related to depression symptoms. People commuting by public transport (e.g. bus or underground railway) were 4.8% less likely to be screened positively for depression compared to those commuting by car. Milner et al. (2017) and Chatterjee et al. (2017) reported that commute duration was negatively associated with MH, while they found active travel to be supportive. However, null associations between commuting and MH have also appeared (Sha et al., 2019a, 2019b).

Given these discrepancies between single studies, literature reviews are central to synthesize the available evidence. However, existing reviews (Chatterjee et al., 2020; De Vos et al., 2013; Delbosc, 2012; Norgate et al., 2019; Reardon and Abdallah, 2013) were limited in scope. For example, Nordbakke and Schwanen (2014) assessed the effects of mobility and wellbeing among the elderly, thus excluding the working population. Reardon and Abdallah (2013) addressed transport–wellbeing relationships, but the outcomes were limited to psychological responses. De Vos et al. (2013) did not include MH in their study. In a non-systematic manner, Chatterjee et al. (2020) provided partial evidence of a relationship between stress and commuting. Norgate et al. (2019) assessed how public transport commuting (e.g. train and bus) affects wellbeing and MH, but ignored active commuting, which is often found to be beneficial for MH (Feng and Boyle, 2014; Martin et al., 2014).

Altogether, reviews have disregarded how commuting is related to MH, have not explicitly focused on commuting and have not been carried out systematically. To address these knowledge gaps, we conducted a systematic review in order to assess 1) how commuting is related to different dimensions of SWB and MH, and 2) how different SWB/MH dimensions are associated.

2. Methods

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009).

2.1. Eligibility criteria

We reviewed only observational studies; experimental and laboratory-based study designs were excluded due to potential discrepancies between the participants' stated preferences and intentions and their actual behaviour (Brüggemann and Bizer, 2016; Sun et al., 2013). Following earlier reviews (Norgate et al., 2019), our inclusion criteria were: (a) published before 9 February 2020; (b) any geographical area; (c) written in English; (d) published as a peer-reviewed article; (e) involved commuting to work or university but not travel for leisure or other purposes; and (f) reported outcomes include either wellbeing (e.g. quality of life or travel satisfaction) or MH (e.g. stress or depression), especially in the commuting context.

The exclusion criteria were: (a) not full-length articles, reviews, conference papers or book chapters; (b) transport not related to commuting to/from work or university; (c) studies related to wellbeing and MH but not to commuting; (d) investigated wellbeing and commuting but not MH; and (e) study population aged below 16 or 18 years (i.e. age allowed to drive varies across countries).

2.2. Information sources

Relevant publications were identified from inception to 9 February 2020. The bibliographic search was carried out in six databases, namely Web of Science, Scopus, American Psychological Association (PsychINFO), National Centre for Biotechnology Information (PubMed), Excerpta Medica dataBASE (EMBASE) and Transport Research International Documentation (TRID).

2.3. Search strategy

Search terms were selected based on keywords from individual studies and earlier reviews on transport, wellbeing and MH. Wellbeing-related terms included: welfare, wellbeing, subjective wellbeing, quality of life, happiness, satisfaction, life satisfaction; those for MH were: depression, anxiety, mental, pressure, tension, psychological health, mental health, depressive symptoms, mood, major depression; and those for transport were: commute, commuting, transport, travel, work travel and mobility. For the queries for each database, see the Supplementary materials.

2.4. Study selection

The records identified from the databases were downloaded and merged in Endnote. After removing duplicates, the titles and abstracts of the remaining studies were screened according to the eligibility criteria. In the case of ambiguities, the full text was assessed. All eligible articles were used for full-text screening.

2.5. Data extraction

Relevant data of the included studies were extracted using a template covering the author(s), year of publication, location of the study site, study design, sample size, characteristics of the population, outcomes measures, results and conclusions. Ambiguity in data extraction was resolved by consensus among the authors.

2.6. Quality assessment of studies

We used the standard quality assessment criteria for evaluating primary research papers from a variety of fields (Kmet et al., 2004) to evaluate the quality of each study. This tool allows a systematic assessment of both quantitative and qualitative research and has been applied in transport-related systematic reviews (Norgate et al., 2019).

Quantitative studies were assessed based on 14 items, each scored either a yes – 2 points (i.e. fully meeting the criterion), partial – 1 point (i.e. partially meeting the criteria), no – 0 points (i.e. not meeting the criteria), or n/a (i.e. not applicable to this study design). Qualitative studies were assessed using 10 items calculated similarly, but "n/a" was not permitted in any of the items. The summary score was calculated as [(number of "yes"s $\times$ 2) + (number of "partial"s $\times$ 1)] / [total items $\times$ 2 – (number of "n/a"s $\times$ 2)]. Scores between 0.85 and 1 refer to high quality, between 0.70 and 0.84 to medium quality and $<$ 0.70 to low quality (Norgate et al., 2019).

2.7. Data synthesis

To summarize the extracted data, we wrote a narrative to synthesize the findings to identify reported SWB and MH, their associations with commuting characteristics and the relationship between different dimensions of SWB and MH. The included studies were too heterogeneous in terms of designs, participants, methods and outcomes (e.g. different aspects of MH, SWB and commuting characteristics) for a meta-analysis.

3. Results

3.1. Study selection

The search strategy resulted in a total of 12,270 articles. After

removing duplicates and screening the titles and abstracts against our inclusion/exclusion criteria, 293 articles remained for a detailed inspection. After the full-text screening, 45 articles fulfilled the inclusion criteria. Fig. 1 shows the study selection.

3.2. Study characteristics

Table 1 summarizes characteristics of the included studies. Studies were conducted globally, with most carried out in the United States (n = 13). Twenty-one were from Europe (UK 7; Netherlands 3; Germany 3; Sweden 3; Ireland 1; Italy 1; Spain 1; Norway 1; Belgium 1), five from Asia and one each from Canada, Australia and New Zealand. Two studies were multicentre (i.e. Latin American countries and European cities). One did not report a location (Koslowsky and Krausz, 1993).

Of the 45 studies, 84% (n = 38) were cross-sectional and seven were longitudinal (Avila-Palencia et al., 2018; Knott et al., 2018; Martin et al., 2014; Morris and Zhou, 2018; Mytton et al., 2016; Roberts et al., 2011; Synek and Koenigstorfer, 2019). Two studies were qualitative (i.e. focus groups were interviewed) (Tenorio et al., 2019; Wild and Woodward, 2019).

3.3. Participants

Sample sizes varied considerably from 20 (Tenorio et al., 2019) to 24,000 participants (Morris and Zhou, 2018). Many studies (69%, n = 31) were based on > 500 subjects, including five national panel surveys (Chng et al., 2016; Higgins et al., 2018; Knott et al., 2018; Martin et al., 2014; Morris and Guerra, 2015; Morris and Zhou, 2018; Roberts et al., 2011). Six studies had < 100 participants.

The mean age of participants was 39.38 years (SD = 9.08) across the 22 studies that reported age. Of the 33 studies that reported gender, more than half included more females than males. Six studies focused on specific population groups: Koslowsky and Krausz (1993) focused on nurses, Ruger et al. (2017) recruited diplomats, and four studies were based on undergraduate students or university employees (i.e. Eriksson et al., 2013; Glasgow et al., 2018; Handy and Thigpen, 2019; LaJeunesse and Rodriguez, 2012).

3.4. Characteristics of the commute

The definition of "commuting" varied. About half (49%) of the studies did not provide any definition, but instead used the general public's perception of it; 22 studies defined it as "travel from home to work/university". In one case, "commuting" referred to traveling to or from work, but excluded travel by public transport for other activities between the commute to and that from work (Lancee et al., 2017). On average, the commute duration was 34.70 mins (SD = 16.03) across the 15 studies that reported duration.

One study measured commute distance and duration objectively through a distance recorder mounted on the participants' bicycles (de

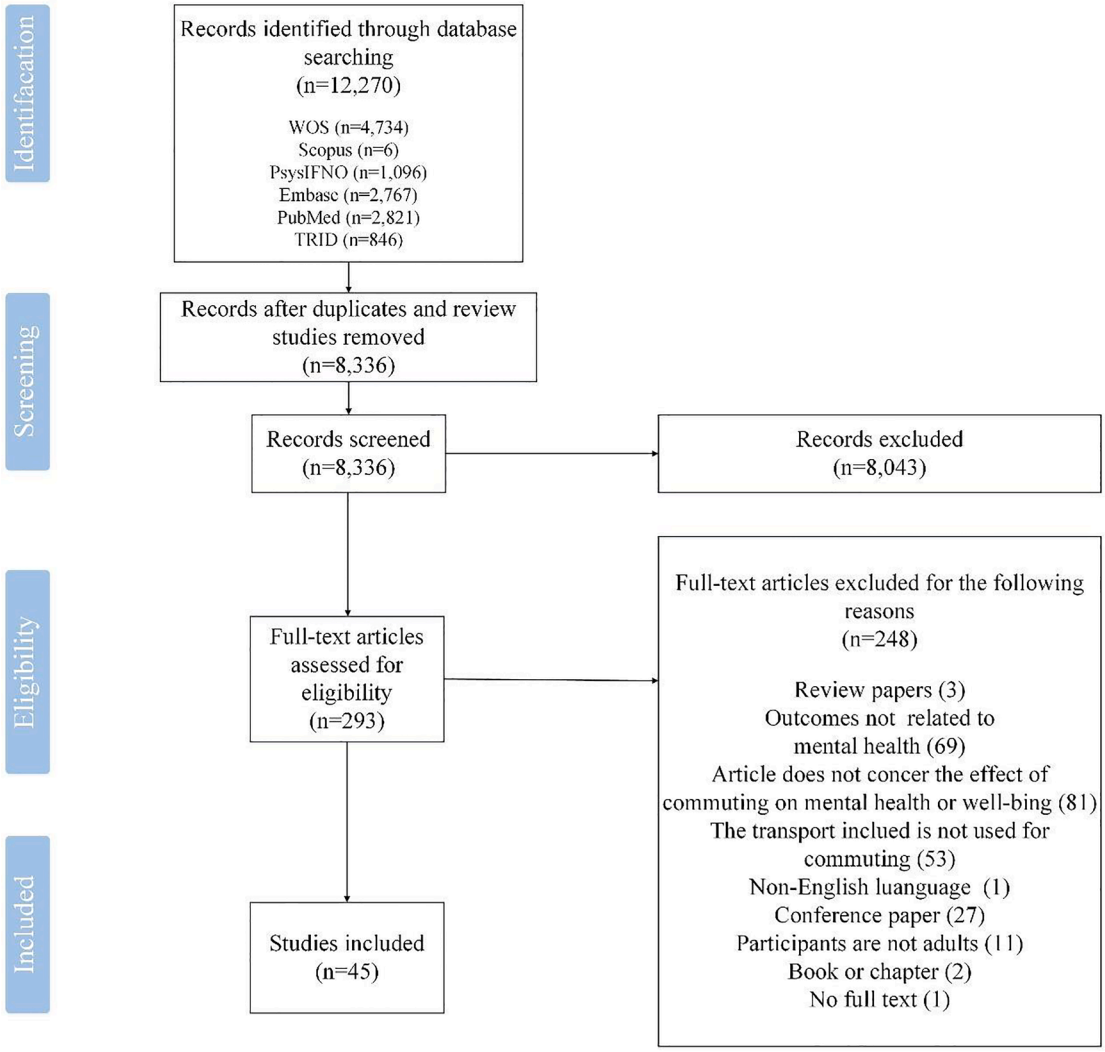

Fig. 1. Flow diagram of the study selection.

Table 1
Summary of the study characteristics.

Reference	Location	Research design	Sample	Well-being	Measures of well-being	Mental health	Measures of mental health	Quality	Results
Avila-Palencia et al. (2017)	Spain	Cross-sectional	N = 788; age > 18			Perceived stress	PSS-4	High (1.00)	Bicycle commuters had lower stress levels than non-bicycle commuters; higher frequency of cycling contributes to lower stress; attitude towards cycling and environmental determinants influences commuters' stress
Avila-Palencia, et al. (2018)	Seven European cities	Longitudinal	N = 3,567; adults > 16 or 18			Perceived stress; mental health; vitality	PSS-4; MHI-5; SF-36	High (0.95)	Active commuting was positively and motorized commuting was negatively associated with general health and mental wellbeing
Chng et al. (2016)	UK	Cross-sectional	N = 3,630	Life satisfaction	How dissatisfied or satisfied are you with your life overall?	Mental distress	GHQ	High (0.85)	Walking had higher life satisfaction and lower mental distress than car commuting; transport connectivity was negatively associated with mental distress for public transport
Chrisinger et al. (2019)	USA	Cross-sectional	N = 3,288; adults aged > 18	Individual-level well-being	SWLS	Experience of emotions; stress; resilience	SWLS	High (0.95)	SWLS and MH unassociated with bicycle commuting but associated with public transport commuting; SWLS associated with socioeconomic indicators and some neighbourhood factors
Comerford (2011)	Ireland	Cross-sectional	N = 815			Enjoyable	How would you rate the enjoyment of the time you spend (driving/ traveling by bus) to work?	Medium (0.75)	Experience during commute differs from that after commute. Affective average inversely correlated with enjoyment for driver and positively for car users
de Geus et al. (2008)	Belgium	Longitudinal	N = 80; aged 30–65	QOL	SF-36	Mental health	SF-36	Medium (0.77)	Cycling at self-paced intensity was positively associated with MH for men, negatively for women; cycling had a positive influence on QOL
Denstadli et al. (2017)	Norway	Cross-sectional	N = 689; company employee	Satisfaction with work–family balance (WFB); commute satisfaction	Questionnaire	Commute stress	Directly: the commute to work is stressful to me (5-point scale); Indirectly: (commute predictability; parental duties; mode)	Medium (0.70)	Car commuting correlated with commuting stress more than active commuting, but no more than public transport; commute satisfaction positively related to satisfaction with WFB; commuting time and perceived

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Table 1 (*continued*)

Reference	Location	Research design	Sample	Well-being	Measures of well-being	Mental health	Measures of mental health	Quality	Results
									stress negatively related to commuting satisfaction; commute duration, predictability and parental duties negatively related to commuting stress
Eriksson et al. (2013)	Sweden	Cross-sectional	N = 123; undergraduates	Satisfaction with Travel Scale; overall satisfaction	STS; SWLS	Residual mood	SCAS	Medium (0.75)	Car commuting had higher STS than bus commuting; travel mode choice affected mood during the day and was mediated by STS; travel mode unrelated to daily SWB after controlling for mood
Ettema et al. (2017)	Sweden	Cross-sectional	N = 363	Travel satisfaction	A shortened STS	Mood	SCAS: How do you feel right now?	High (0.85)	Active commuting had more positive mood after commuting than motorized; no difference in travel satisfaction between seasons but influenced by weather conditions (sunshine was negatively associated with mood for cycling and walking); bad weather was negatively related to positive mood; mood directly after commuting associated with the mood before the commute and some weather variables
Evans and Wener (2006)	USA	Cross-sectional	N = 208; aged 25–60			Indices of stress (salivary cortisol, task motivation and perceived stress)	Salivary cortisol: collected with a Salivette; Motivation: persistence on a proofreading task; Perceived commuting stress: questions from previous work	High (0.85)	Longer commuting positively associated with stress and poor proofreading performance
Friman et al. (2017b)	Sweden	Cross-sectional	N = 146	Satisfaction with travel	STS	Emotional wellbeing	How do you feel right now?	High (0.85)	Emotional responses to critical incidents affect mood after the trip and commute satisfaction; travel mode uncorrelated with mood changes immediately after the commute; residual mood influences the affect dimensions of the STS
Gimenez-Nadal et al. (2019)	USA	Cross-sectional	N = 5,805; workers but excluded self-employed, aged 21–65			Happiness, stress, sadness, fatigue and pain	A 7-point scale question	Medium (0.70)	Commute duration positively associated with stress and fatigue, had negative spill-over to childcare;

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Table 1 (*continued*)

Reference	Location	Research design	Sample	Well-being	Measures of well-being	Mental health	Measures of mental health	Quality	Results
									commuters reported higher level of happiness, more stress and more fatigue than non-commuters
Glasgow et al. (2018)	USA	Cross-sectional	N = 738; Undergraduate students	Travel satisfaction scales	STS	Mood	TMS	High (0.90)	Active commuting associated with better general mood, relaxation and travel satisfaction than motorized; talking to others improved general mood and relaxation; males reported better mood state than females
Handy and Thigpen (2019)	USA	Cross-sectional	N = 2,702; undergraduates, graduates, faculty, staff	Overall commute satisfaction	Questionnaire	Commute stress	Traveling to campus stresses me out?	Medium (0.80)	Bus commuting leads to high commute stress, followed by car, train, active commuting; reverse order for commute satisfaction
Higgins et al. (2018)	Canada	Cross-sectional	N = 3,319; age ≥ 16; employed	Commute satisfaction	Questionnaire	Congestion-related stress	Questionnaire	Medium (0.75)	Frequency and congestion duration positively associated with stress; congestion associated with commute dissatisfaction
Humphreys et al. (2013)	UK	Cross-sectional	N = 989; working adults age > 16	Physical wellbeing	SF-8	Mental wellbeing	SF-8	Medium (0.80)	Active commuting unrelated to mental wellbeing; active commuting time positively associated with physical wellbeing
Kent et al. (2019)	Australia	Cross-sectional	N = 317; age > 18	Physical wellbeing; Cognitive SWB	SF-12-v2; SWLS	Mental wellbeing; affective SWB	SF-12-v2; two questions	Medium (0.80)	Commuting time and time spent traveling inversely associated with mental wellbeing and SWB; appreciating driving results in higher mental wellbeing and SWB; past experiences of commuting time influence commuting stress
Knott et al. (2018)	UK	Longitudinal	N = 5474; adults aged 40–75			Depressive symptoms	PHQ-2	High (0.90)	Switching from inactive to active commuting associated with less severe depressive symptoms; longer commuting associated with worse depressive symptoms
Koslowsky and Krausz (1993)		Cross-sectional	N = 682 nurse aged 19–64	Job satisfaction	Three items	Stress	Question from Pines et al. (1981)	Low (0.65)	Commuting time positively related to stress, especially for car drivers as compared with public transport users
LaJeunesse and Rodriguez (2012)	USA	Cross-sectional	N = 786; University	Commuting competence	Questions adapted from	Dispositional mindfulness;		Medium (0.80)	Bus and active commuting induced

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Table 1 (*continued*)

Reference	Location	Research design	Sample	Well-being	Measures of well-being	Mental health	Measures of mental health	Quality	Results
			employees aged 19–72		Reis et al. (2000)	commute-related stress and attunement	MAAS; DASS-21; single-item question		less stress than driving; active commuting lowered stress and led to higher positive affect than motorized modes
Lancee et al. (2017)	Netherlands	Cross-sectional	N = 1,328	Happiness	Happiness diary	Mood/affect	Participants rated how well they had felt during each activity	High (0.90)	Active commuting had highest affect, followed by car and bus; long working days and traveling alone lower mood; commuting effects on mood were largely similar across socio-demographic groups
Martin et al. (2014)	UK	Longitudinal	N = 17,985; aged 18–65	Job satisfaction	Questionnaire	Psychological wellbeing	GHQ12	High (0.85)	Car commute duration negatively associated with wellbeing; active commuting duration positively associated with wellbeing; active commuting positively associated with psychological wellbeing; switching from car to more active commuting led to higher level of psychological wellbeing
Mauss et al. (2016)	Germany	Cross-sectional	N = 3,805; aged 16–64;	Wellbeing	SF-12	Perceived stress; exhaustion; mental health	PSS; Maastricht Vital Exhaustion Questionnaire; SF-12	Medium (0.75)	Commuting was not associated with wellbeing and MH
Mohd Mahudin et al. (2012)	Malaysia	Cross-sectional	N = 525			Stress; exhaustion	SACL; GWBQ	High (0.89)	Feelings of crowdedness associated with stress and exhaustion; affective feelings of crowdedness mediate rail commuters' MH
Morris and Guerra (2015)	USA	Cross-sectional	N = 22,800; adults			Mental state: happiness, sadness, fatigue, pain, stress	Questionnaire	High (0.90)	Mood negatively associated with commute duration; car driving/cycling resulted in higher stress in longer commutes; happiness of car passengers increased with trip duration but declined for bus commuters
Morris and Zhou (2018)	USA	Longitudinal	N = 24,000; full-time employed adults	Life satisfaction	Cantril ladder life satisfaction question	Emotions: happiness, sadness, stress, fatigue, pain and a sense of meaning	Questionnaire	High (0.95)	Affect during trip not related to commute duration; mood at work negatively associated with commute duration; life satisfaction not related to commute duration; negative affect during

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Table 1 (*continued*)

Reference	Location	Research design	Sample	Well-being	Measures of well-being	Mental health	Measures of mental health	Quality	Results
									commute spills over to work
Mytton et al. (2016)	UK	Longitudinal	N = 801; Age > 16	Physical wellbeing	PCS-8	Mental wellbeing	MCS-8	High (0.90)	Cycling positively associated with mental wellbeing and physical wellbeing, negatively related to sickness absence; walking had no association
Novaco and Collier (1994)	USA	Cross-sectional	N = 2,591; worked full-time exclude the home worker, age > 18			Indices of commute stress ("commuting satisfaction" & subjective impedance indices & three new items question)	commuting satisfaction& subjective impedance indices: questions from previous work;	Medium (0.80)	Commute duration and distance associated with commute stress; women had higher commute satisfaction than men and perceived more commuting stress spill-over to work and home; full-time ride-sharers had higher level of commuting satisfaction than solo drivers
Novaco et al. (1991)	USA	Cross-sectional	N = 99	Residential satisfaction;	Questionnaire	Mood; dysphoria	Questionnaire; Global Stress Scale	Medium (0.70)	Physical impedance (PI) and morning congestion were associated with location satisfaction; PI was positively related to negative mood and dysphoria; commuting time and evening commuting were negatively associated with negative home mood
Novaco et al. (1990)	USA	Cross-sectional	N = 79	Satisfaction with different domains	Questionnaire	Mood	Six semantic differential scales with bipolar anchors	Medium (0.70)	Subjective impedance was positively associated with chest pain, negatively associated with home mood; commuting satisfaction had a positive impact on job change; PI was positively related to illness work absences and bad physical health, and negatively associated with job satisfaction, commute satisfaction and travel aversion
Roberts et al. (2011)	UK	Longitudinal	N = 15,077; aged 18–65	Job satisfaction;	Single-item question; SAH	Psychological health	GHQ	High (0.95)	Commuting had a detrimental effect on the psychological health of women but not men; commuting time had no effect on MH for men, had adverse effect on

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Table 1 (*continued*)

Reference	Location	Research design	Sample	Well-being	Measures of well-being	Mental health	Measures of mental health	Quality	Results
									women except those with a flexible working time; those commuting by passive modes (public transport and car passengers) had better MH than those commuting by active modes (car, motorcycle, cycle, walk)
Rüger et al. (2017)	Germany	Cross-sectional	N = 1,928; Foreign Service employees	Health-related quality of life	QLQ-C30	Stress	PSQ	Low (0.65)	Commuting time positively related to perceived stress and negatively related to health-related quality of life; female parents suffered more adverse effects from longer commuting time
Scheepers et al. (2015)	Netherlands	Cross-sectional	N = 3,075; age > 18			Psychological wellbeing	MHI-5	Medium (0.80)	Active commuting positively associated with general health and BMI; transport choice uncorrelated with psychological wellbeing
Sha et al. (2019a)	China	Cross-sectional	N = 990	Life satisfaction,	SWLS-5	Mental distress	CHQ-12	High (0.9)	Commute duration negatively related to life satisfaction and unrelated to mental distress
Sha et al. (2019b)	China	Cross-sectional	N = 813; employed;	SWB	SWLS	Mental distress	CHQ-12	High (0.85)	Commuting time negatively related to life satisfaction; no association with mental distress
Singleton (2019)	USA	Cross-sectional	N = 682; age > 18	Satisfaction with Travel Scale; travel eudaimonia	STS; Self-created question	Travel affect	PANAS-type approach	Medium (0.70)	Active commuters had better physical wellbeing and MH; travel time negatively associated with travel SWB and MH; women reported a lower travel SWB and MH than men; experience of travel usefulness negatively associated with travel SWB and affect
Smith (2017)	USA	Cross-sectional	N = 828; Aged > 25	Commuting wellbeing; job and residential satisfaction	Modified STS; questionnaire	Affective component	Questionnaire	Medium (0.80)	Active commuting resulted in highest level of commute wellbeing (CWB); commuting time and traffic delay negatively related to CWB; carpool and express bus users had higher CWB than solo drivers and local bus users; job and residential satisfaction positively related to CWB
	Germany	Longitudinal			PCS-8		MCS-8		

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Table 1 (*continued*)

Reference	Location	Research design	Sample	Well-being	Measures of well-being	Mental health	Measures of mental health	Quality	Results
Synek and Koenigstorfer (2019)			N = 462; aged 18–64	Physical wellbeing		Mental wellbeing		High (0.85)	Bicycle commuting and bicycle commuting time positively associated with mental wellbeing
Tenorio et al. (2019)	Philippines	Qualitative analysis	N = 20; aged 20–30			Stress	Focus group discussions	Medium (0.70)	Seating privileges and stuck in public transport affect commuters' stress and wellbeing; feelings and experience of stress during commuting shapes their decision making
Thomas and Walker (2015)	UK	Cross-sectional	N = 1,609			Affect: exciting, Pleasant, Relaxing, Depressing, Boring, Stressful	Method of Gatersleben and Uzzell (2007)	Medium (0.70)	Active commuting had higher affective appraisal than bus; car commuting showed no association with affect
Turchi et al. (2019)	Italy	Cross-sectional	N = 197			Mental health; vitality	SF36	High (0.85)	Commute duration negatively associated with general health and physical function; males had better MH than females
van Hooff (2015)	Netherlands	Cross-sectional	N = 76	Recovery experiences	Recovery Experience Questionnaire	Serenity; Anxiety; Stressful delays	PANAS-X; three self-developed items	Medium (0.80)	Commuting time uncorrelated with recovery state; experiencing relaxation and detachment during commute contributes to employees' recovery
Wang et al. (2019)	Latin American	Cross-sectional	N = 5,438; aged 20–60			Depressive symptoms	CESD	High (0.95)	Commuting time and traffic delay positively associated with depression; public transport accessibility negatively associated with depression; underground railway and bus rapid transport reduced depression; non-motorized transport uncorrelated with depression
Wild and Woodward (2019)	New Zealand	Qualitative analysis	N = 24; people aged 35–44					High (0.85)	E-bike commuters had higher levels of perceived commuting control and time reliability; had less stress than car commuters; showed improved MH when cycling through nature
Zhu and Fan (2018)	China	Cross-sectional	N = 921; aged 18–60	Overall wellbeing	3-items question	Commute happiness	How happy did you feel during your latest commute from home to work?	High (0.90)	Active commuting associated with greater happiness; commute duration negatively associated with happiness; shuttle

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Table 1 (*continued*)

Reference	Location	Research design	Sample	Well-being	Measures of well-being	Mental health	Measures of mental health	Quality	Results
									bus commuters had higher level of happiness than public bus users

SWLS-5: Satisfaction with Life Scale-5; CHQ-12: Chinese Health Questionnaire-12; PHQ-2: Two-item Patient Health Questionnaire; CESD: Center for Epidemiologic Studies Depression; STS: Satisfaction with Travel Scale; BSI-18: Brief Symptom Inventory; QLQ-C30: Quality of Life Questionnaire-Core 30; PSQ: Perceived Stress Questionnaire; PCS-8: Physical Component Summary; SF-8: Medical Outcomes Study Short Form Questionnaire; SACL: Stress and Arousal Checklist; GWBQ: General Well-Being Questionnaire; MAAS: Mindfulness Awareness Attention Scale; DASS-21: Depression Anxiety Stress Scale; SF-36: The Medical Outcome Study Short Form; PSS-4: Short version of the Perceived Stress Scale; TMS: Travel Mood Scale; SWLS: The Stanford WELL for Life Scale; SCAS: Swedish Core Affect Scale; MCS-8: Mental Component Summary; SAH: Standard self-assessed heal; MHI-5: Mental Health Inventor

Geus et al., 2008). Friman et al. (2017b) used GPS-enabled smartphones to track participants' trips; however, GPS data were not analysed due to incompleteness. The remaining studies employed self-report questionnaires or travel diaries to collect commuting data.

There was a lack of consensus on whether a one-way or round trip to work constitutes "commuting". Seven studies considered it as one-way trip to work, while one also included returning home from work (van Hooff, 2015). Five measured round trips, while Novaco et al. (1990) and Novaco et al. (1991) distinguished between morning and evening commutes. Moreover, the most significant commuting characteristics were mode and duration, which slightly varied across regions (Figure S1).

3.5. Overview of SWB and MH indicators

SWB and MH are complex concepts with various operationalizations (Diener, 1994; OECD, 2013; Palumbo and Galderisi, 2020). SWB comprises affective and cognitive components (Diener and Ryan, 2009; Diener et al., 2009). The former describes the experienced wellbeing including both positive and negative affect, while the latter captures an individual's satisfaction with life as a whole or specific sub-domains (e.g. travel satisfaction). The measurement of SWB therefore can concern momentary experiences or longer term states, and be specific for one domain (e.g. travel) or more general (Ettema et al., 2010a; Mokhtarian, 2019; De Vos et al., 2013).

Many definitions of MH exist. Simply spoken, MH is not merely the absence of mental illness (e.g. depression and anxiety), but also includes maintaining healthy psychological and social functioning (Galderisi et al., 2015, 2017; Huber et al., 2011; Jahoda, 1958; Keyes, 2006; Keyes and Lopez, 2009; World Health Organization, 2010).

Most studies assessed commute satisfaction with the STS, while Denstadli et al. (2017) used multiple items on commute time, commute stress and travel cost. Domain satisfaction in terms of home and job was measured with either a single item (Chng et al., 2016) or multiple items. Measures to assess life satisfaction (quality of life), cognitive SWB and overall wellbeing levels included the SF-36, QLQ-C30, SWLS, GHQ-12 and single-item questions (e.g. "How dissatisfied or satisfied are you with your life overall?") (Table S2).

Some studies used a mix of questionnaires to assess MH based on stress, specific mental illness (e.g. depression) and general MH. Stress – including commute-related stress and perceived stress – was assessed variously using the PSS-4, PSQ, SACL, DASA-21, etc. Novaco and Collier (1994) and Evans and Wener (2006) used a multi-methodology to capture commuting stress based on salivary cortisol, task motivation and perceived stress. Three studies quantified depressive symptoms using the PHQ-2 and the CESD-10. The SF-36 and the GHQ-12 were widely used to measure general MH (Table S3).

There was no standard measure of emotional wellbeing. Mood and affect were measured differently (e.g. SCAS or PANAS). Some used selected questions adapted from previous studies (Novaco et al., 1991; Thomas and Walker, 2015). To assess enjoyment and feelings of happiness, Zhu and Fan (2018), Comerford (2011) and Smith (2017) used a single-item question (Table S3).

3.6. Commuting characteristics and their relationship to SWB

3.6.1. Life satisfaction and quality of life

The reported commuting characteristics that affect life satisfaction and quality of life were commute duration and mode. Life satisfaction seemed to decline with increasing commute duration (Rüger et al., 2017; Sha et al., 2019a, 2019b). However, Morris and Zhou (2018) reported a null finding. Walking commuters, but not bike commuters, reported higher life satisfaction than car users (Chng et al., 2016); whereas de Geus et al. (2008) found that bicycle commuting was positively related with quality of life. Moreover, different types of public transport modes were differently associated with life satisfaction (Chng et al., 2016; Eriksson et al., 2013). Attitudes towards transport were also associated with cognitive SWB; that is, commuters who favoured driving and car travel had higher SWB (Kent et al., 2019).

3.6.2. Commute satisfaction

Satisfaction with commute is related to various commuting characteristics. Studies have shown that commute satisfaction seems to be mode-dependent and that active commuting has the highest commute satisfaction (Glasgow et al., 2018; Singleton, 2019; Smith, 2017). However, findings concerning the effects of walking and cycling on commute satisfaction were inconsistent. For example, Handy and Thigpen (2019) found that walkers reported more commute satisfaction than cyclists, while Smith (2017) reported that cycling to work had the highest commute satisfaction. In some studies, car commuters reported more commute satisfaction than bus commuters (Eriksson et al., 2013; Handy and Thigpen, 2019; Smith, 2017).

Critical for commute satisfaction seemed to be shorter trip durations, which were shaped by traffic congestion, delays, etc. (Denstadli et al., 2017; Higgins et al., 2018; Singleton, 2019; Smith, 2017). For instance, spending a long time in traffic jams significantly reduced travel satisfaction; that is, commute duration matters, but commuting in congested conditions matters even more (Higgins et al., 2018). In Smith (2017), however, duration was insignificantly associated with commute satisfaction for public transport and bicycle commuters. Attitude towards commute time also shapes travel satisfaction. Those who considered commute time useful reported higher commute satisfaction than those who rated it as useless (Denstadli et al., 2017; Handy and Thigpen, 2019; Smith, 2017).

Commuting with or without a companion influences commute satisfaction. Rideshare and carpool commuters reported higher commute satisfaction than solo car commuters (Novaco and Collier, 1994; Smith, 2017). Others also found that emotional response to critical incidents (e.g. vague travel information), socio-demographics (e.g. income and gender), weather conditions, physical health and talking to others play a role (Ettema et al., 2017; Friman et al., 2017b; Glasgow et al., 2018; Handy and Thigpen, 2019; Singleton, 2019; Smith, 2017).

3.6.3. Satisfaction in other domains

A few studies investigated how commuting correlates with satisfaction in other domains (e.g. job and home). For example, commuting possibly affects the satisfaction with the work–family balance indirectly via commute satisfaction (Koslowsky and Krausz, 1993). Physical impedance during commuting (e.g. distance) was significantly associated with residence satisfaction (Novaco et al., 1991).

3.7. Association between commuting and mental health outcomes

3.7.1. Stress

Commuting affects people's stress levels. Studies have shown that commute duration and distance are inversely associated with both commute-related stress and self-perceived stress (Denstadli et al., 2017; Novaco and Collier, 1994; Rüger et al., 2017). Additionally, Evans and Wener (2006) reported that salivary cortisol (a stress-related biomarker) increased with pronounced commute duration compared to baseline. The effects of commute duration on stress also differ across modes: the level of stress in drivers and cyclists increased with longer commutes, but not in car passengers (Morris and Guerra, 2015). However, insignificant associations between perceived stress and commuting have also been reported (Avila-Palencia et al., 2017; Mauss et al., 2016).

The level of stress varies across commute modes. Cycling and walking resulted in the lowest risk of experiencing stress (Denstadli et al., 2017; Koslowsky and Krausz, 1993; LaJeunesse and Rodriguez, 2012). Others reported that bicycle commuting, but not walking, reduced perceived stress (Avila-Palencia et al., 2018). Solo car commuters reported the highest stress levels, while driving with a companion seemed to buffer against commuting stress (Handy and Thigpen, 2019; Novaco and Collier, 1994). The stress levels across public transport mode users were not clear. Mode-unconstrained commuters reported lower stress levels compared to those who needed to use a specific mode (Handy and Thigpen, 2019).

Commute stress also depended on sociodemographics. Women experienced more stress than men during commuting, and the stress level varied across population groups (e.g. students were more stressed than faculty staff) (Handy and Thigpen, 2019; Novaco and Collier, 1994; Rüger et al., 2017). The subjective perception of commuting also matters. For example, rail commuters' stress experience was shaped by their subjective feelings of crowdedness. Even when crowdedness was objectively measured as low, if it was perceived as unpleasant, passengers experienced stress (Mohd Mahudin et al., 2012).

3.7.2. Depression

Depression is shaped by commute duration, transport modes and traffic delay. Longer commutes increase the risk of more depressive symptoms (Knott et al., 2018). Wang et al. (2019) found that every additional 10 min of commuting duration increased the likelihood of being screened with depression by 0.5%. Moreover, compared to car commuting, commuting by public transport (e.g. bus or underground railway) was inversely correlated with depressive symptoms (Wang et al., 2019). Switching from passive to active commuting reduced the risk of being depressed, but not in the case of long-distance commuting at baseline (Knott et al., 2018). Traffic congestion and delay were negatively associated with depression (Wang et al., 2019).

3.7.3. General mental health

General MH was associated with some commuting characteristics. Roberts et al. (2011) showed that general MH assessed via the GHQ dropped by 0.055 with every 10-minute increase in commute duration and that this adversely affected women but not men. However, the effects of commute duration on general MH were inconsistent across modes. Time spent on active commuting was positively associated with general MH, while others reported negative associations between time spent on driving and general MH (Martin et al., 2014; Synek and Koenigstorfer, 2019). Cycling contributed to general MH, but no significant associations were found with increased cycling time (de Geus et al., 2008; Mytton et al., 2016).

The relationship between commute mode and general MH was unclear. Some found positive relationships between active commuting and general MH (de Geus et al., 2008; Mytton et al., 2016), while others found it only for cycling (not walking) (Avila-Palencia et al., 2018). General MH was higher among those who actively commuted compared to public transport and car users; additionally, switching from car to active commuting was beneficial for general MH (Martin et al., 2014). Roberts et al. (2011) found that travel modes that require active operation (i.e. car, motorcycle, bicycle and walking) seemed to reduce general MH more than passive ones (e.g. public transport and car passenger). Insignificant associations were also reported elsewhere (Chng et al., 2016; Humphreys et al., 2013; Mauss et al., 2016; Scheepers et al., 2015; Sha et al., 2019a, 2019b).

The built environment and attitudes to commuting were also related to general MH. Cross-sectional data from the UK showed that local public transport connectivity was inversely correlated with GHQ scores; the result did not hold for train commuting, however (Chng et al., 2016). Commuters who resented commute time because they felt that it is a waste of time and they consequently had less time for other activities had lower general MH. Moreover, earlier commute departure time decreased general MH (Kent et al., 2019).

3.8. Commuting and emotional response

Emotional wellbeing is a component of both SWB and MH. Emotional response to commuting differed across modes. Commuting by nonmotorized modes contributed more to positive affects than motorized modes. For instance, active commuters scored higher on "pleasant", "exciting" and "relaxing", while those commuting by bus or car scored low on "exciting", "pleasant and "relaxing" and higher on "stressful" (Thomas and Walker, 2015). Similarly, Singleton (2019) reported that nonmotorized mode users rated attentiveness and enjoyment higher than motorized commuters. In contrast, others also found that car commuters had more fun (Eriksson et al., 2013; Lancee et al., 2017). Evidence from China suggested that commuters who use their employers' shuttle buses feel happier than private bicycle users and walkers; however, there was no significant difference between public transport mode (e.g. underground railway or public bike) and car commuters (Zhu and Fan, 2018).

Commute duration was another factor that influenced commuters' emotional state. Longer commutes increase fatigue (Gimenez-Nadal and Molina, 2019; Morris and Guerra, 2015) and reduce feelings of happiness (Zhu and Fan, 2018). Moreover, these effects could spill over to work and home. For instance, positive affects at work dropped by about 2.7% when commuting time was extended by 30 min (Morris and Zhou, 2018). Sadness and fatigue during childcare activities increased by 0.062 and 0.126 units, respectively, with every 1% increase in commuting time (Gimenez-Nadal and Molina, 2019). The affects of car commuters with longer commutes were lower than those with shorter commutes, while the difference in mood between public transport and multimodal users was minor (Lancee et al., 2017). Negative emotions (e.g. fatigue and sadness) in drivers were negatively associated with commute duration; negative emotions in car passengers did not increase with commute duration (Morris and Guerra, 2015).

Moreover, commuting with someone improved mood compared with commuting alone (Glasgow et al., 2018; Lancee et al., 2017). Physical impedance during commuting was positively correlated with negative mood and evening commuting was strongly associated with negative mood at home (Novaco et al., 1991). In addition, weather conditions play a role in commuters' mood. Commuters reported more positive mood with an increase in temperature and felt displeased when commuting in adverse weather conditions (e.g. snow or rain) (Ettema et al., 2017). However, this effect differed according to travel mode.

3.9. Correlations between different dimensions of SWB and MH

A few studies assessed the interplay between different dimensions of SWB and MH. Thirty-four studies (Table S4) included indicators of both SWB and MH; however, nearly half (n = 16) did not explore this interrelation.

The available evidence showed three major relationships between SWB and MH. First, the commuting-stress-SWB hypothesis (Cooper, 2013; Koslowsky et al., 2013; Koslowsky and Krausz, 1993; Rüger et al., 2017) suggested that higher commute-related stress resulted in lower SWB. Rüger et al. (2017) found that increased stress due to long commutes was correlated with lower health-related quality of life. Denstadli et al. (2017) found that perceived stress was negatively related to commute satisfaction. Similarly, studies also reported that higher stress during commute reduced commute satisfaction (Handy and Thigpen, 2019; Higgins et al., 2018) and that stress acted as a mediator between commute time and job satisfaction for car driving (Koslowsky and Krausz, 1993).

Second, emotional response to commuting affects diverse aspects of SWB. Emotional response to critical incidents and mood immediately after a commute influenced the STS (Friman et al., 2017b). Studies also showed that positive mood (e.g. relaxation and serenity) during commuting was positively associated with recovery at home (van Hooff, 2015) and commute satisfaction (Glasgow et al., 2018). Moreover, less mental distress was likely to be contributing to pronounced life satisfaction (Sha et al., 2019b).

Finally, SWB contributed to emotional wellbeing and general MH. Commuters with higher SWB (i.e. being optimistic, usually happy and with no illness) felt happier during their commutes (Zhu and Fan, 2018). STS partially mediates the effects of travel mode on mood during the day (Eriksson et al., 2013). Moreover, health status and job satisfaction were positively related with GHQ scores (Roberts et al., 2011).

3.10. Study quality

The studies on commuting and SWB and MH were, in general, of good quality, ranging from 0.65 to 1.0 (Table 1). Twenty-three studies were rated as high, 20 as medium and only 2 as low. Reasons for a lower score were a poor description of sample selection (e.g. sampling strategy and selection methods), subjects' characteristics, analytical methods or methodological shortcomings (e.g. limited adjustment of confounders).

4. Discussion and conclusions

4.1. Main findings

This paper reviewed how commuting affects different aspects of wellbeing and MH. The review is the first to include the effects of commuting on both SWB and MH. In line with previous findings (Norgate et al., 2019; Nordbakke and Schwanen, 2014; Chatterjee et al., 2020; Ettema et al., 2010a; De Vos et al., 2013), commuting characteristics, travel circumstances, travel attitude, and personality are found to influence different dimensions of SWB. Alternatively, our results complement existing commuting-MH associations, mainly focusing on stress, emotion, and/or depression specific aspects, by including multiple MH outcomes (i.e. stress, specific mental disorder, general state, and emotional response) (Gärling, 2019; Chatterjee et al., 2020; Marques et al., 2020). Furthermore, we identify the possible commuting–SWB–MH interplay suggesting that the stress and emotional responses experienced by commuters shape their SWB and MH, and a happier commuter may report better MH.

The aspects of SWB and MH differed in the extent to which they reflect more experiential aspects related to the commute (commute satisfaction, stress and emotional response) or more general mental and cognitive states (life satisfaction, depression and general MH). Altogether, a main outcome of the reviews was that commute duration and travel mode were found to affect experiential indicators of wellbeing and MH as well as more general mental and cognitive states. Confirming previous review findings (De Vos et al., 2013; Chatterjee et al., 2020), a longer commute was consistently found to lower the level of MH and wellbeing. Note that this deteriorating effect was especially found when some threshold duration was exceeded, suggesting that excess commuting seemed to be harmful. Concerning the commute mode, active travel (walking and cycling) had positive effects on both the experience of commuting and the more general mental and cognitive state. This finding aligns with earlier work (Ettema et al., 2016). An important implication is that acceptable commute durations and active travel modes not only make commuting a more enjoyable experience, but also contribute to greater life satisfaction and better MH, while reducing the risk of experiencing depressive symptoms.

Experiential aspects of wellbeing and MH (commute satisfaction, stress and emotional response) were found to be affected by numerous travel circumstances, such as crowdedness, weather conditions, the occurrence of incidents, the presence of company, etc. The fact that most of these circumstances were place-dependent and not constant over time may explain why no structural impact on life satisfaction, general MH and depression were found. However, also crowdedness, which was more likely to be a structural travel condition, did not seem to carry over to the structural wellbeing and MH. Moreover, experiential aspects of SWB and MH were affected by certain trip characteristics when using a certain travel mode. For car users, for example, the commute experiences were likely to be affected by elements such as traffic congestion, road conditions and punctuality, while public transport commuters were more concerned with service quality and the availability and accessibility of public transport.

Finally, a number of personal characteristics were associated with wellbeing and MH as found elsewhere (Delbosc 2012; Chatterjee et al., 2020). Attitudes towards travel modes were related to life satisfaction and commute satisfaction as well as to emotional wellbeing. It was, however, not clear how this relationship unfolded: Were commuters happier because they had a positive attitude towards cars? Or did a higher life satisfaction lead to a more positive emotional response to car travel? Notably, personal characteristics such as health and socioeconomic status were related to commute satisfaction and commute stress, and shaped emotional response to travel, implying that commute experiences vary depending on personal characteristics.

In terms of the causalities between wellbeing and MH indicators, no definitive conclusions can be drawn due to a lack of longitudinal studies. A hypothesis could be that the accumulation of commute experiences leads to changes in overall wellbeing and MH (Ettema et al., 2010a; De Vos et al., 2013), as supported by the reported effects of stress and emotional response on life satisfaction or domain satisfaction. However, commuters with higher life satisfaction (or better general mental state) may also be better able to cope with commuting experiences, resulting in better emotional responses and better MH, which was also confirmed through our review.

4.2. Strengths and limitations

To our knowledge, this review is the only one to comprehensively summarize up-to-date findings on commuting, SWB and MH in a systematic manner. We followed a prespecified search strategy that minimized the reviewers' study selection bias. Another strength is that we considered SWB and MH broadly.

However, some limitations must be emphasized. First, we only included published articles in the English language; thus, it is likely that we missed some studies in other languages and grey literature. Additionally, a few studies had no research terms that were used for the search strategy in their abstract, and keywords and could not be obtained. Second, studies were predominantly conducted in developed countries in Europe and North America, which may limit the generalization of our finding to other contexts. Third, SWB and MH were

typically assessed using various dimensions and multiple-choice screeners, which to some extent contributed to mixed findings. Fourth, the majority of the studies were based on people's experiences and perceptions, which are susceptible to response bias. Finally, more than three quarters of the studies were cross-sectional; therefore, it is impossible to draw causal conclusions about how commuting affects SWB/MH.

4.3. Suggestions for future research

Most studies assessed how SWB or MH as dependent variable correlates with travel-specific explanatory variables. Constrained by cross-sectional designs, causal links could not be established. Reverse causation (i.e. travel does have an impact on SWB and MH, and in turn, wellbeing and mental state also can affect travel) (Abou-Zeid and Ben-Akiva, 2011; De Vos and Witlox, 2017) and various operationalizations of the dependent variables are likely to have contributed to the identified mixed findings. Therefore, it is essential that future research is based on longitudinal data analysed through statistical models capable of disentangling the interwoven relationships (e.g. structural equation models).

In transport research, the most frequently assessed factors related to commuting experience are instrumental attributes (e.g. cost, duration and mode) and affective attributes (e.g. stress, relaxing and feelings while using the services) (Anable and Gatersleben, 2005; Ye and Titheridge, 2019). Personal characteristics also shape the commute experience by affecting travel behaviour (De Vos and Witlox, 2017; Jamal and Newbold, 2020). Future research should address the personal characteristics–commute experience associations, while moderation analyses should be used to quantify how effect sizes vary across population groups and different environmental settings.

Burgeoning mobility solutions (e.g. ride-hailing and car- and bike-sharing) provide an alternative and more sustainable way to meet environmental targets (European Environment Agency, 2010), which will result in both social and economic benefits (Efthymiou et al., 2020). Shared mobility systems make travel more flexible, available and accessible (Firnkorn and Müller, 2011). Emerging mobility solutions such as these directly or indirectly contribute to wellbeing and MH, as they may allow commuters to reduce their spending on transport while experiencing the positive characteristics of private and public transport without the accompanying purchase and maintenance costs. Because shared mobility and traveller's commute satisfaction remain rather unexplored, future studies should verify how shared mobility is associated with commuter's satisfaction and how traveller's satisfaction with shared mobility affects its adaption and development.

Social interaction is positively associated with wellbeing and MH (Cooper et al., 2018; Rasmussen, 2018). Travel contributes to social interaction by playing an instrumental or indirect role in reaching various activities (Frank et al., 2019). Engagement in out-of-home activities requires travel to get to them, or activities during destination-oriented travel contribute to wellbeing and/or MH as they may help personal growth via social participation (De Vos et al., 2013; Mokhtarian, 2019). Social engagement during or after travel also affects wellbeing – for example, car commuting decreases opportunities for face-to-face interactions, which help to establish trust (Urry, 2002) – while commuting by public transport can increase social interaction through close contact with other travellers. Therefore, questions such as "What is the role of social interaction in the association between travel and wellbeing/MH?" should be put on research agendas.

Most studies measured wellbeing and mental state post-exposure (e.g. several days or weeks later), and thus the data are likely to be biased due to memory distortions (Kahneman, 2000). Retrospective data collection may not match the various mental states in an ambulatory context (Vila et al., 2019). Experience during travel is likely to differ from that after travel (i.e. experience of the whole journey) (Friman et al., 2017b; Mokhtarian, 2019). Wearable sensors and smartphone devices could complement traditional survey-based data collection while obviating recall bias (Chaix, 2018; Marzano et al., 2015; Vila et al., 2019). GPS-enabled wearables and smartphones could provide objectively measured high-resolution spatiotemporal data on individuals' exposures and physiology data en route (Birenboim et al., 2021). Echoing recent calls to study the impact of dynamic mobility-based environment exposure on mental health (Helbich, 2018), wearable sensors with integrated geo-tracking seem promising to leverage future research on monitoring traveller's mental state and wellbeing, and to assess how dynamically changing environments along people's daily paths changes their emotional wellbeing and physiology.

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CRediT authorship contribution statement

Jiakun Liu: Conceptualization, Data curation, Formal analysis, Funding acquisition, Writing – original draft, Writing – review & editing. **Dick Ettema:** Conceptualization, Supervision, Writing – review & editing. **Marco Helbich:** Conceptualization, Supervision, Writing – review & editing.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tbs.2022.02.006.

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