Can the mode, time, and expense of commuting to work affect poor mental health?

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Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author statement

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Declaration of competing interest

The authors declare that they have no competing interest.

Acknowledgements

The authors would like to thank the City of Mairena del Aljarafe for supporting the execution of the survey for this study, the pollsters, and respondents who participated in the survey.

Abstract

Commuting to work is an important part of many people's daily life, with travel times have constantly on the rise and becoming a growing problem. The aim is to assess the associations between commuting and poor mental health in workers. This is a cross-sectional study extracting information from the 'Commuting, Daily Habits and Urban Health Survey' in Mairena del Aljarafe (Spain) including a representative sample of 294 workers. Poor mental health were accessed using the 12-item General Health Questionnaire (GHQ-12). Associations were tested using Mann-Whitney and Chi-square tests, while Pearson's correlation was used for each item in the GHQ-12, and multiple linear regression was applied to explore factors associated with poor mental health. Of the 294 workers, the mean age was 43.1 years old, 46.6% female, 49% university study, 38.4% smoked, and 44.5% were overweight/obese. For their commute, 77.1% used a private motor vehicle (vs. 6.9% public and 16.0% active), allocated 51.9 min/day (54.8

min/day private, 44.2 min/day public, and 39.3 min/day active), and spent €91.9/month (€99.7/month private, €59.0/month public and €59.5/month active). The multiple linear regression model shows that people who use their private motorised transport and those who spent longer time on their commutes are associated with poorer mental health. The results of this study show us that both driving a motor vehicle and commute length are associated with poorer mental health. Therefore, the use of public and/or active commuting should be encouraged, as well as better management to improve traffic congestion and thus reduce commuting times.

Keywords: commuting, private vehicle, public transport, active commuting, mental health, work.

1. Introduction

Motor vehicles emit air pollutants (Walsh, 2011) that are adverse to health and contribute to respiratory disease and cardiovascular diseases (Lee et al., 2014), however, most people do not consider the risk (Beirão and Sarsfield Cabral, 2007). People who travel by car or bus have greater exposure to pollution than those who travel by train, bicycle, or on foot (Chertok et al., 2004).

The most common mode of commuting to work is the private motor vehicle (Clark et al., 2019; Feng and Boyle, 2014). Public transport is faster due to dedicated lanes or for city centre travel, however, longer bus commutes have been found to lower job satisfaction and boredom (Clark et al., 2019; Gatersleben and Uzzell, 2007), thus for longer distances the favoured mode of transport is the private motor vehicle (Beirão and Sarsfield Cabral, 2007). Active commuting is associated with greater happiness than travelling in motor vehicles (Abou-Zeid and Ben-Akiva, 2011). Many workers, especially females, report feeling more stressed by having to drive to work and state that if they could use public transport they would be able to read or socialise during the commute (Beirão and Sarsfield Cabral, 2007; Roberts et al., 2011). Car transport produces higher levels of stress and worse concentration than active commuting (Martin et al., 2014). Our role as we commute plays has a role, with those in non-operating modes (such as walkers or passengers) experiencing lower levels of distress due to the fact that less attention needs to be paid than is the case for drivers or cyclists (Singleton, 2019). Driving has an effect on the quality and length of sleep, which in turn can lead to crashes (Lyznicki et al., 1998). In addition, lower levels of commuting traffic are associated with lower levels of driver stress (Hennessy and Wiesenthal, 1999).

Although car drivers themselves acknowledge that they spend less on public transport, this is not a factor in determining the change in mode of transport (Beirão and Sarsfield Cabral, 2007).

Those who switch from motorised transportation to walking reduce their likelihood of obesity, hypertension, diabetes, and mental health disorders (Tajalli and Hajbabaie, 2017). In addition, walking is the most habitual type of physical activity due to the benefits provided (Saelens and Handy, 2008) to physical and mental health (van den Berg et al., 2015). People who travel on active or public transport have lower body mass index (BMI) levels than those who travel in their private vehicle (Flint et al., 2014). On the other hand, those who spend more time driving have higher levels of obesity, poorer quality of life, greater psychological stress and experience physical health or emotional problems (Ding et al., 2014).

Shorter commuting times are associated with greater happiness and less stress (Abou-Zeid and Ben-Akiva, 2011) and longer active commuting time is associated with higher levels of physical wellbeing (Humphreys et al., 2013). Active commuting produces greater wellbeing than public and motorised transport and a longer duration of active commuting produces higher levels of wellbeing (Chng et al., 2016; Martin et al., 2014).

Longer commutes to work are associated with higher levels of stress (Clark et al., 2019) and poorer mental health, with a greater impact on women (Feng and Boyle, 2014).

Many studies have evaluated the characteristics of commuting in relation to health status (Lee et al., 2014), obesity (Ding et al., 2014; Flint et al., 2014; Tajalli and Hajbabaie, 2017), wellbeing (Chng et al., 2016; Humphreys et al., 2013), and mental health.

In addition to our study, we conducted a review of other published research. Table A.1 presents the main characteristics of eleven studies that have evaluated the relationship between commuting and mental health (i.e. study design, baseline characteristics, commuting measure, commuting measure, validated scales and wellbeing variables).

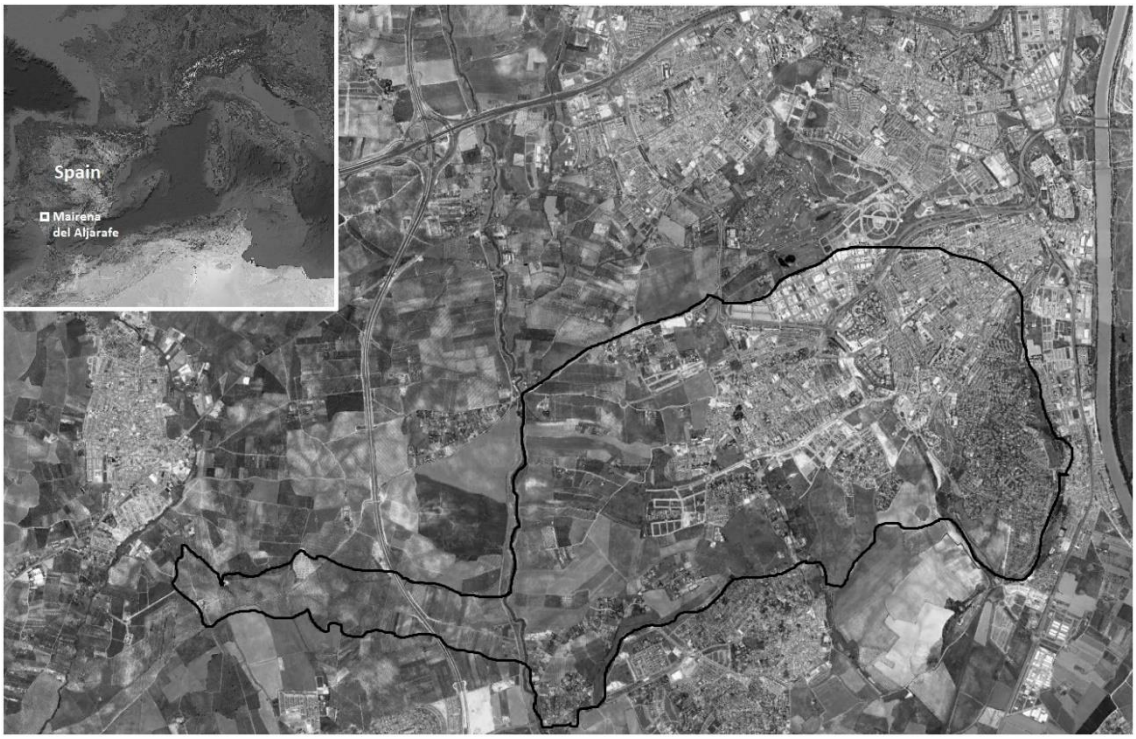
The results of these evaluated studies allow us to contextualise our findings. The aim of the present study is to assess possible associations between commuting to work (mode, expense and time) and the poor mental health of workers, and to analyse the correlation of individual factors of the 12-Item General Health Questionnaire (GHQ-12) with commuting patterns.

2. Materials and methods

2.1 Study area

This study was carried out in Mairena del Aljarafe, a municipality of 44,388 inhabitants (2015) located in the Seville Metropolitan Area (Spain), which occupies a surface of 17.61 Km2 (Figure 1).

Figure 1. Map of the municipality of Mairena del Aljarafe (Spain).



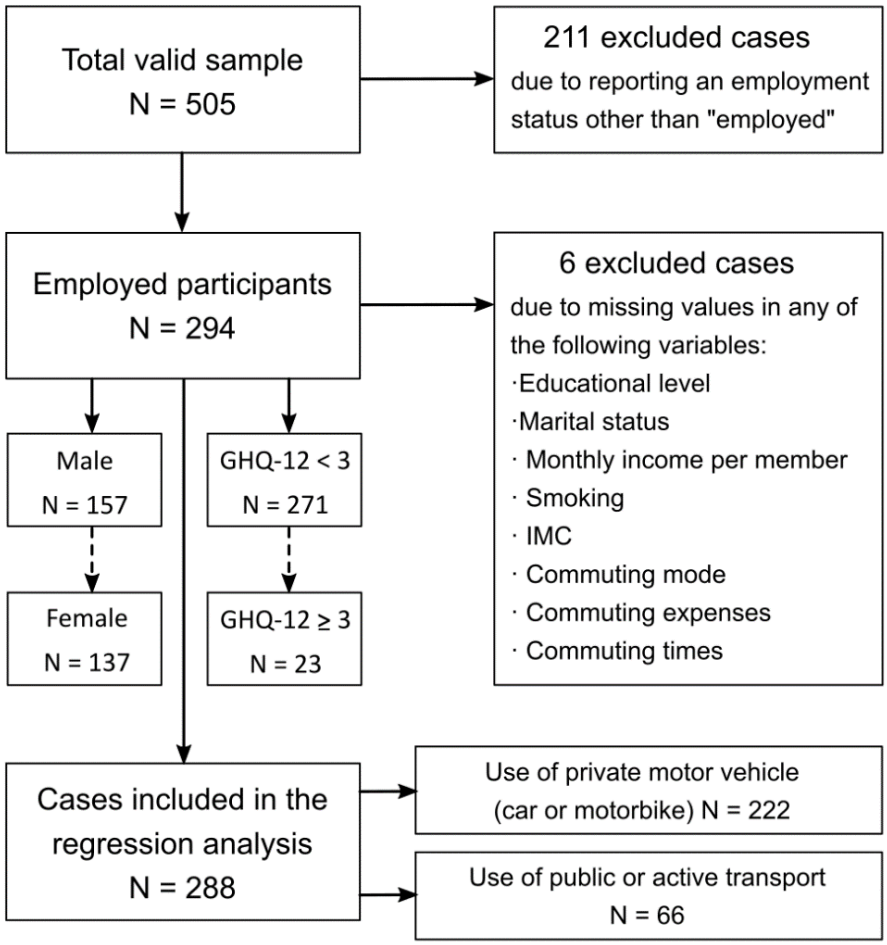
This municipality is characterised by having experienced strong urban expansion associated with spectacular population growth in the last 40 years, giving rise to new urban areas with a predominance of residential land use. As a consequence of this expansion, the transport system has also evolved to connect this municipality with Seville and the rest of the metropolitan area. Mairena has eight bus lines that connect it with other municipalities in the metropolitan area. Due to the expansion that began in the early 1980s, the city was transformed with new real estate developments and facilities, including two metro stations in Mairena connecting the two main nearby cities (Seville and Dos Hermanas). Both stations include a metropolitan bus station with car and bike parking facilities. However, public transportation in many areas is limited to low-frequency public buses that are seldom used.

2.2 Survey

Information on the mental health status of the population was extracted from the “2015 Commuting, Daily Habits and Urban Health Survey”. The survey was carried out between January and April 2015 among a representative sample (16–64 years old) in the municipality of Mairena del Aljarafe who were interviewed face-to-face in their respective households. Two-stage sampling was used with stratification in the first stage units, selecting a random sample within each area. The first stage units corresponded with the urban zones into which the municipality of Mairena del Aljarafe is divided. The second stage units were people aged between 16 and 64 residing in the main family dwelling at the time of the survey. The city hall provided a pollster team of four individuals, plus three additional staff skilled in statistics who performed supervision and data entry tasks. To

reach this representative sample size, an overall of 627 were attempted, of which 122 were discarded for different reasons including refusal to participate in the survey, change of dwelling, low response rate to the questionnaire, or inconsistencies in information provided. Finally, a representative sample was obtained of 505 correctly filled questionnaires that exceeded the size of the sample designed (representativeness threshold was 380 observations). This survey provided abundant information about sociodemographic characteristics, urban mobility patterns, lifestyles, and the mental health status of this population. Specifically, one aspect related to the population residing in the most sprawling areas in Spain is its higher economic level compared to those residing in more compact areas. The following flowchart represents the steps followed for the selection of the analysed sample (Figure 2).

Figure 2. Study sample selection flowchart.



2.3 Variables

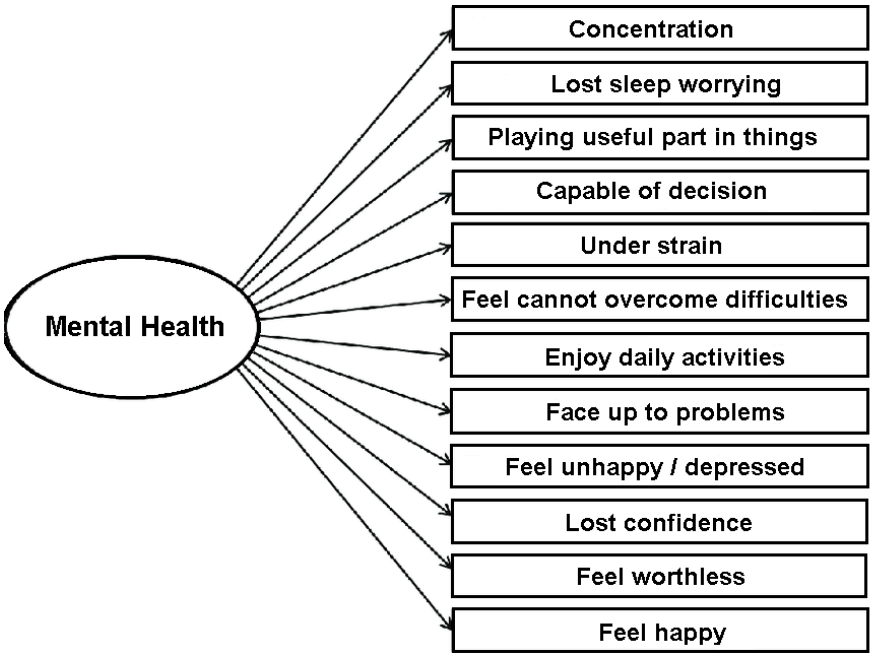
The variables analysed in this study were: (1) Sociodemographic characteristics: age (numerical variable), gender (categorical variable with values: “male”, “female”), marital status (categorical variable with values: “married/or in a relationship”, “single”, “divorced/separated” and “widowed”) and level of education (categorical variable with values: “no schooling”, “primary school” “secondary school” and “university”). (2) Habits of life: smoking (categorical variable with values: “yes” and “no”) and BMI (categorical variable with values: “underweight”, “normal weight”, “overweight” and “obese”). (3) Characteristics of commuting to work: mode of transport to work (categorical variable with values: “private vehicle (car or motorbike)” and “public or active commuting”), commute time (numerical variable and categorical variable with values: “<40min/day” and “>40min/day”), commute expenses (numerical variable and categorical variable with values: “<70€/month” and “>70€/month”). (4) Mental health: General Health Questionnaire (numerical variable and categorical with values: “GHQ <3” and “GHG ≥ 3”).

2.4 General Health Questionnaire (GHQ-12)

Mental health was measured using the GHQ-12, which consists of 12 items (Figure 3), each one assessing the severity of a mental health problem during the previous four weeks using a Likert scale (0-1-2-3). Thus, a maximum score of 36 was obtained; higher scores reflected an increased risk of psychological morbidity. To determine people with poor mental health, scores were transformed into a scale, where 0 or 1 = 0, and 2 or 3 = 1. Following this methodology, the majority of published studies found that scores ≥ than 3 indicated poorer mental health. Therefore, we used this cut-off point for the present study (Cano et al., 2001).

The GHQ-12 is a screening measure for identifying minor psychiatric disorders in the general population, used to encompass common symptoms of anxiety, social dysfunction, and loss of confidence (Hankins, 2008). It is not a diagnostic instrument.

Figure 3. General Health Questionnaire Items (GHQ-12).



2.5 Statistical analysis

A descriptive analysis was conducted using percentages, means and standard deviations.

To analyse the association of the variables with the commuting modes to work, the Chi-square test was used with the categorical variables (sociodemographic, life habits, and mental health) and the Mann-Whitney test for the quantitative variables. Pearson's correlation was used to find linear relationships between the different items of the GHQ-12 and money and time spent commuting to work.

To explain which factors were associated with mental health, a simple and multiple linear regression were carried out, taking GHQ-12 as the dependent variable with the following independent variables: educational level, marital status, monthly income per family member, smoking, BMI, mode of commuting to work, time allocated on commuting to work, and money spent on commuting to work.

These tests provide information about the existence of any statistically significant differences in the variables with a value of $p<0.05$.

3. Results

The sample of workers had an average age of 43.1 years, 53.4% were men, 49.0% had undertaken university studies, and 65.6% were married or in a relationship. Of these workers, 61.6% did not smoke and 44.5% were overweight or obese. With respect to commuting to work, 77.1% used their private vehicle and 22.9% used public or active commuting (6.9% public and 16.0% active). The average commuting time was 51.9 minutes/day, and the average expense for commuting was €91.9/month. Only 7.8% present poor mental health (i.e. GHQ-12 >3) (Table 1).

Table 1. Descriptive analysis of sociodemographic variables, life habits, and commuting patterns of workers (N= 294, unless specified).

Variables		**Mean ± SD or n (%)**
Age		43.1 ± 9.9
Gender	Male	157 (53.4)
	Female	137 (46.6)
Educational level	No schooling	5 (1.7)
	Primary school	61 (20.7)
	Secondary school	84 (28.6)
	University	144 (49.0)
Marital Status	Married/or in a relationship	193 (65.6)
	Single	78 (26.5)
	Divorced/Separated	19 (6.5)
	Widowed	4 (1.4)
Smoking	Non-smoker	181 (61.6)
	Occasionally	38 (12.9)
	<10 cig/month	18 (6.1)
	10-20 cig/month	48 (16.3)
	20-60 cig/month	8 (2.7)
	>60 cig/month	1 (0.3)
BMI	Underweight	6 (2.0)
	Normal weight	157 (53.4)
	Overweight	105 (35.7)
	Obese	26 (8.8)
Commuting mode N: 288	Private vehicle (car or motorbike)	222 (77.1)
	Public or active commuting	66 (22.9)
Commuting times		51.9 ± 52.7
Commuting expenses		91.9 ± 66.3
GHQ-12 score		0.5 ± 1.5
GHQ-12 cut-off	GHQ <3	271 (92.2)
	GHG ≥ 3	23 (7.8)

The average commuting time was 51.9 min/day (54.8 min/day private, 44.2 min/day public, and 39.3 min/day active commuting), and the average expense was €91.9/month (€99.7/month private, €59.0/month public, and €59.5/month active commuting). Compared to those who used public or active commuting, people who commuted using a private motor vehicle had a higher educational level (university) (54.1% vs 31.8%, p<0.001), were mostly married/in a relationship (68.9% vs 56.1, p=0.031), had a higher prevalence of being overweight/obese (46.4% vs 37.9%, p=0.050), allocated more time to commuting (54.8min/day vs 40.8min/day, p=0.002), and spent more money on their commute (€99.7/month vs €59.3/month, p<0.001) (Table 2).

Table 2. Bivariate analysis of sociodemographic variables, living habits and commuting patterns, differentiating by mode of transport (N=288, unless specified).

	Mean ± SD or n (%)
	Commuting Mode

		Private vehicle (car or motorbike)	Public or active commuting	p-value
Age		43.1 ± 9.7	43.5 ± 10.9	0.613
Gender	Male	126 (56.8)	29 (43.9)	0.067
	Female	96 (43.2)	37 (56.1)	
Educational level	No schooling	0 (0.0)	5 (7.6)	**<0.001***
	Primary school	32 (14.4)	27 (40.9)	
	Secondary school	70 (31.5)	13 (19.7)	
	University	120 (54.1)	21 (31.8)	
Marital status	Married/or in a relationship	153 (68.9)	37 (56.1)	**0.031***
	Single	49 (22.1)	26 (39.4)	
	Divorced/Separated	16 (7.2)	3 (4.5)	
	Widowed	4 (1.8)	0 (0.0)	
Monthly income per respondent		1,006.8 ± 497.6	833.3 ± 537.6	**0.003***
Smoking	Non-smoker	139 (62.6)	37 (56.1)	0.521
	Occasionally	24 (10.8)	13 (19.7)	
	<10 cig/month	15 (6.8)	3 (4.5)	
	10-20 cig/month	37 (16.7)	11 (16.7)	
	20-60 cig/month	6 (2.7)	2 (3.0)	
	>60 cig/month	1 (0.5)	0 (0.0)	
BMI	Underweight	2 (0.9)	4 (6.1)	**0.050***
	Normal weight	117 (52.7)	37 (56.1)	
	Overweight	81 (36.5)	21 (31.8)	
	Obese	22 (9.9)	4 (6.1)	
Commuting times. Min/day		54.8 ± 57.7	40.8 ± 30.2	**0.002***
Commuting expenses. Euro/month		99.7 ± 64.4	59.3 ± 40.1	**<0.001***
GHQ-12 (≥ 3)		19 (8.6)	3 (4.5)	0.281

Compared to workers who allocated less than 40 minutes commuting, 52.0% of workers who took more than 40 minutes each day to travel to work had a university education (vs 42.2%, p=0.012), and only 21.6% did not smoke (vs 34.4%, p=0.020). In addition, 80.8% of those who used a private vehicle (car or motorbike) allocated more than 40 minutes per day for their daily commute (vs. 19.2% of those who used public or active commuting, p=0.026). Workers who spent more than €70 per month on commuting were university educated (54.7% vs 36.6% who spent less than €70, p<0.001), non-smokers (80.1% vs 62.4% who spent less than €70, p=0.001) and inclined to be less overweight/obese (41.8% vs 50.5% who spent less than €70, p<0.001). In addition, 86.2% of those using their private vehicle (car or motorbike) spent more than €70 per month on commuting (vs. 13.8% using public or active commuting, p<0.001) (Table 3).

Table 3. Bivariate analysis of sociodemographic variables, living habits and commuting, differentiating by commuting times and commuting expenses (N=294, unless specify).

	Mean ± SD or (%)					
	Commuting times			**Commuting expenses**		
	<40min/day	**>40min/day**	**p-value**	**<€70/month**	**>€70/month**	**p-value**
Age	42.3 ±10.1	43.4 ± 9.9	0.467	42.0 ± 11.1	43.6 ± 9.3	0.303

Gender - Male - Female	47 (52.2) 43 (47.8)	110 (53.9) 94 (46.1)	0.788	45 (48.4) 48 (51.6)	112 (55.7) 89 (44.3)	0.241
Educational level - No schooling - Primary school - Secondary school - University	2 (2.2) 29 (32.2) 21 (23.3) 38 (42.2)	3 (1.5) 32 (15.7) 63 (30.9) 106 (52.0)	**0.012***	5 (5.4) 34 (36.6) 20 (21.5) 34 (36.6)	0 (0.0) 27 (13.4) 64 (31.8) 110 (54.7)	**<0.001***
Marital status - Married/or in a relationship - Single - Divorced/Separated - Widowed	53 (58.9) 32 (35.6) 3 (3.3) 2 (2.2)	140 (68.6) 46 (22.5) 16 (7.8) 2 (1.0)	0.056	54 (58.1) 33 (35.5) 4 (4.3) 2 (2.2)	139 (69.2) 45 (22.4) 15 (7.5) 2 (1.0)	0.075
Monthly income per respondent	1,017.7 ± 613.5	947.5 ± 457.3	0.697	929.1 ± 569.2	987.5 ± 480.8	0.151
Smoking - Yes - No	31 (34.4) 59 (65.6)	44 (21.6) 160 (78.4)	**0.020***	35 (37.6) 58 (62.4)	40 (19.9) 161 (80.1)	**0.001***
BMI - Underweight - Normal weight - Overweight - Obese	4 (4.4) 40 (44.4) 35 (38.9) 11 (12.2)	2 (1.0) 117 (57.4) 70 (34.3) 15 (7.4)	0.054	6 (6.5) 40 (43.0) 32 (34.4) 15 (16.1)	0 (0.0) 117 (58.2) 73 (36.3) 11 (5.5)	**<0.001***
Commuting mode N: 288 - Private vehicle (car o motorbike) - Public or active commuting	62 (68.9) 28 (31.1)	160 (80.8) 38 (19.2)	**0.026***	53 (57.6) 39 (42.4)	169 (86.2) 27 (13.8)	**<0.001***
GHQ-12 - GHQ-12 < 3 - GHQ-12 ≥ 3	80 (88.9) 10 (11.1)	191 (93.6) 13 (6.4)	0.163	86 (92.5) 7 (7.5)	185 (92.0) 16 (8.0)	0.898

As commuting time increased, workers who used their private vehicle experienced greater sleep loss (r=0.148), felt more pressure (r=0.152), felt more depressed (r=0.134), and had generally poorer mental health (r=0.146). Furthermore, as commuting expenses increased, workers who used their private vehicle reported greater sleep loss (r=0.224), felt they were not playing a useful role (r=-0.199), greater pressure (r=0.284), more depressed (r=0.174), and less happy (r=-0.149). For public or active commuting, we were unable to obtain any of these results (Table 4).

Table 4. Correlation between time and money spent on commuting and each of the items of GHQ-12, differentiating by mode of transport.

GHQ-12 items	**Private vehicle (car or motorbike)**	
	r correlation	
	Commute times	**Commute expenses**
Concentration	0.114	-0.025
Lost sleep worrying	**0.148***	**0.224****
Playing useful part in things	-0.036	**-0.199****

Capable of decision	0.028	-0.100
Under strain	**0.152***	**0.284****
Feel cannot overcome difficulties	0.124	0.116
Enjoy daily activities	-0.018	0.051
Face up to problems	-0.048	-0.116
Feel unhappy/depressed	**0.134***	**0.174***
Lost confidence	-0.009	0.109
Feel worthless	0.006	0.032
Feel happy	0.125	**-0.149***
Total	**0.146***	0.080

*<0.05 **<0.005. P-value for r=0 test

For simple linear regression analysis all of the variables are significant, therefore those with a higher level of education, who are married or in a couple, with a higher income, smokers, workers with a higher BMI, who commute to work by car or motorbike, and who spend more time and money on commuting to work tend to have poorer mental health (p<0.001). The multiple linear regression model shows that people who use their private motor vehicle (B=0.156, p=0.035) and those who allocated more time to commuting (B=0.197, p=0.008) are associated with poorer mental health (Table 5).

Table 5. Multiple linear regression between mental health GHQ-12 (dependent variable) and sociodemographic characteristics, living habits and commuting patterns (independent variables, N= 288).

	Univariable linear regression		**Multivariable linear regression**	
	Beta	**p-value**	**Beta**	**p-value**
Educational level	0.129	**<0.001***	-0.048	0.702
Marital status. Married/ or in a relationship	0.440	**<0.001***	-0.056	0.516
Monthly income per respondent (€)	0.001	**<0.001***	-0.093	0.336
Smoking. Yes	0.335	**<0.001***	0.062	0.553
BMI	0.017	**<0.001***	0.044	0.704
Commuting mode. Car or motorbike	0.514	**<0.001***	0.156	**0.035***
Commuting expenses	0.004	**<0.001***	-0.076	0.536
Commuting time	0.007	**<0.001***	0.197	**0.008***

4. Discussion

The present study provides evidence on the relationships between certain commuting patterns and workers' mental health. Our findings show that workers who use their private motor vehicle (car or motorbike) and those who allocated more time commuting to work are associated with poorer mental health. Furthermore, workers who used their private motor vehicle had a higher educational level, were mostly married/in a relationship, had a higher prevalence of overweight/obesity, allocated more time to their commute, and spent more money on commuting. In addition, workers who allocated more time and spent more money commuting were more educated, smoked less, had a higher prevalence of being overweight/obese, and used their own vehicle. For mental

health, associations were found with lost sleep due to worry, a reduced sense of playing a useful role, and feelings of being under strain, unhappy, or depressed. With respect to daily commuting, 77.1% used their private motor vehicle, 6.9% used public transport and 16.0% engaged in active commuting. It is interesting to note that most workers used a car to commute to work (209 of them) and only a small proportion drove a motorbike (13 of them). The average commuting time was 51.9 min/day (54.8 min/day private, 44.2 min/day public transport, and 39.3 min/day active commuting), and the average expense was €91.9/month (€99.7/month private, €59.0/month public transport and €59.5/month in active commuting).

Our results show that worrying sleep loss was related to the use of a car or motorbike for a longer period during commuting. Sleep loss can trigger other factors such as increased stress at work, greater family stress, poor lifestyle habits such as smoking or becoming obese, and poorer self-perceived health (Lallukka et al., 2011). Furthermore, in a study by Lyznicki et al. (1998) it was found that driving to work impacts on the quality and duration of sleep (Lyznicki et al., 1998). According to our results, longer commuting times and increased expenditures for travel by motor vehicle (car or motorbike) were correlated with higher levels of feeling under strain. These results point in the same direction as those of the study by Martin et al. (2014), in which car commuting was associated with increases in drivers' strain (Martin et al., 2014). Furthermore, Ding et al. (2014) found that those who allocated more time driving presented more psychological stress, which aligns with our study. According to our results, among workers who commute to work by car, feeling strain was associated with increased time and money spent on commuting to work. However, this stress can be derived from the impossibility of getting to work on time. In fact, personal concerns, such as getting to work on time, can increase frustration, irritation, and other negative effects associated with the demands of driving (Hennessy and Wiesenthal, 1999).

In our study, 7.8% of workers were found to have poor mental health. The majority of workers (77.1%) use a private motor vehicle to commute and these data are aligned with other studies in which the vast majority use private motor vehicles for commuting (Clark et al., 2019). In our study, the average monthly expenditure on commuting is €92 and travel time is 52 minutes. Those who used private motor vehicles to commute to work had a higher level of education, were mostly married or in a relationship, and spent more time and money on commuting.

Our results confirm previous studies in which commuters using private vehicles had a higher educational level (Tajalli and Hajbabaie, 2017) and spent more money on commuting (Beirão and Sarsfield Cabral, 2007), compared to those using public transport or engaged in active commuting. Workers who used public or active commuting

allocated less time and money than those who used their own private vehicle. In this line, a study by Clark et al. (2019) revealed that active commuting times, including bicycle or walking, were lower compared to car commuting times, although bus or metro had the longest commuting times.

In addition, longer commutes are associated with poorer mental health, which is in line with previous studies (Feng and Boyle, 2014). Although some previous studies have found an association between commuting and poor psychological health in females (Roberts et al., 2011), we did not find any significant gender differences.

One of the strengths of our study is the representativeness of the sample by age and gender studied in addition to using multiple commuting patterns such as mode, time, and expense. Another strength is the use of the GHQ-12, a validated scale for the screening of poor mental health, together with the separate use of each of its individual items.

This study has some limitations associated with the cross-sectional nature in which conclusions on causality cannot be reached, although it allows us to establish possible associations.

Regarding the theoretical-practical contribution, the results provide evidence for the need to reduce private vehicle travel and, at the same time, promote the use of active or public transportation as a preventive measure to improve the mental health of the population. The initial aim of exploring associations between commuting mode, travel time, and commuting cost in relation to mental health has been achieved.

5. Conclusions

This study shows how those using their private motor vehicle feel under pressure, less happy and their sleep quality is affected; all of these factors lead to increased travel times and commuting costs. Finally, people who use their private motor vehicle to commute to work and those who have longer travel times are more associated with poorer mental health. At the same time, respondents who used public or active commuting allocated less time and spent less. Therefore, the use of public and/or active commuting should be encouraged, along with better management to improve traffic congestion and thus reduce commuting times.

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Appendices

Table A.1. Studies on the characteristics of commuting and wellbeing

Reference	Study design and baseline characteristics	Commuting measure	Validated Scales	Wellbeing variables
Hennessy & Wiesenthal, 1999	**Sample size**: 60 **Age**: 21-60 years who commuted to or from school/work **Study area**: Toronto **Research design**: cross-sectional **Statistical Method**: ANOVA test and regression analysis **Source**: interviewed over cellular telephones **Year**: N/A	- Commuting to work/college	- Driving Behaviour Inventory-General (DBI-Gen) - State Driver Stress Inventory - State Driving Behavior Checklist	- Stress - Driver aggression - Information seeking - Minor self-destruction - Relaxation techniques - Planning - Distraction
Feng & Boyle, 2014	**Sample size**: 5,216 **Age**: between 16 and 64 years **Study area**: England, Wales, and Scotland **Research design**: longitudinal 18 waves of data (1991-2008) have been released **Statistical Method**: Regression, models (Odds ratio) / multivariate analysis **Source**: General Health Questionnaire **Year**: 1991 to 2008	- Commuting time	- General Health Questionnaire (GHQ-12)	- Psychological distress
Martin, Goryakin, & Suhrcke, 2014	**Sample size**: 17,985 adults **Age**: aged 18–65 years who commute to work **Study area**: British Household **Research design**: longitudinal data (1991-2009) **Statistical Method**: regression models **Source**: British Household Panel Survey **Year**: 1991-2009	- Commuting time - Commuting mode	- General Health Questionnaire (GHQ-12)	- Overall psychological wellbeing
Humphreys, Goodman, & Ogilvie, 2013	**Sample size**: 989 **Age**: Commuters aged 16 and over **Study area**: Cambridge **Research design**: cross-sectional **Statistical Method**: Univariable linear regression **Source**: postal questionnaire **Year**: 2009 **Country:** Cambridge, UK	- Commuting time	- Medical Outcomes Study Short Form survey (SF-8).	- Mental wellbeing
Roberts, Hodgson, & Dolan, 2011	**Sample size**: 15,077 **Age**: 18–65 year old employees **Study area**: UK **Research design**: longitudinal data (1991-2004) **Statistical Method**: Own econometric method to make estimates **Source**: British Household Panel Survey (BHPS) **Year**: 1991-2004	- Commuting time - Commuting mode	- General Health Questionnaire (GHQ-12)	- Psychological health

Gatersleben & Uzzell, 2007	**Sample size**: 389 **Age**: 19–64 year old employees **Study area**: UK **Research design**: cross-sectional **Statistical Method**: Percentages, Chi-square tests, correlation and regression analysis **Source**: e-mail survey **Year**: 2000	- Commuting time - Commuting mode	- Two-dimensional model of affect proposed by Russell & Lanius	- Stressful, exciting, boring, relaxing, pleasant, and depressing
Chng, White, Abraham, & Skippon, 2016	**Sample size**: 3,630 **Age**: N/A **Study area**: London **Research design**: cross-sectional **Statistical Method**: linear regression and logistic regression **Source**: UKHLS **Year**: 2010/2011	- Commuting mode	- General Health Questionnaire (GHQ-12)	- Mental distress - Wellbeing
Ding, Gebel, Phongsavan, Bauman, & Merom, 2014	**Sample size**: 37,570 **Age**: aged 47–75 years **Study area**: New South Wales **Research design**: cross-sectional **Statistical Method**: Chi-square test, ANOVA test and Multiple logistic regression **Source**: Medicare Australia database **Year**: 2010	- Commuting time	- Medical Outcomes Study 12-Item Short-Form Health Survey (SF-12) - Kessler-10	- Self-rated health - Psychological distress
Tajalli & Hajbabaie, 2017	**Sample size**: 2,650 **Age**: over 18 **Study area**: New York City **Research design**: cross-sectional **Statistical Method**: Chi-square test, ANOVA test and Binary Probit Model **Source**: Community Health Survey (CHS) **Year**: 2010	- Commuting mode	- Non-Specific Psychological Distress (NSPD) variable	- Mental health
Singleton, 2019	**Sample size**: 682 **Age**: over 18 **Study area**: Portland **Research design**: cross-sectional **Statistical Method**: structural equation models (SEMs) and MIMIC models **Source**: email survey **Year**: 2016	-Commuting time -Commuting mode	- The Satisfaction with Travel Scale (STS) - PANAS - Eudaimonic SWB	- Distress, fear, attentiveness and enjoyment - Positive activation, positive deactivation and cognitive evaluation - Security, autonomy, confidence and health
Clark, Chatterjee, Martin, & Davis, 2019	**Sample size**: 79,793 **Age**: 16 - 87 years **Study area**: England **Research design**: longitudinal **Statistical Method**: descriptive analysis and regression analysis **Source**: UKHLS **Year**: 2009-2015	- Commuting time - Commuting mode	- General Health Questionnaire (GHQ-12)	- Mental health