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Urban mobility and health: a multicentric survey conducted in some Italian cities

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Abstract

Introduction. Urban and transport planning, environmental exposures, physical activity and human health are strictly linked. The aim of this study was to analyze the determinants of sustainable and active mobility in 4 Italian provinces.

Materials and methods. An online multiple-choice survey was administered via Google Form between October 2019 and February 2020.

Results. 605 people answered the questionnaire, reporting their mobility practices. The home location did not seem to influence mobility behaviours, with the exception of the greater use of public transport for those who did not live in the province capital. Working or studying in central areas was associated with less use of the car, while not working or studying in the province capital was associated with less use of the motorbike. Women use cars more, and motorcycles/bicycles less. Age and educational level did not seem to influence mobility practices, while being a student compared to a worker was related to greater use of public transport and tendency to walk to the work/study place as well as to lesser car use.

Discussion. It is essential that all cities adopt solutions to encourage healthy mobility. The positive relationship between BMI and car use, between good food score and bike use and between frequent light physical activity and healthy mobility indicators confirmed that risk factors are often interconnected and that improving even one single habit could have a positive effect on the others as well.

Conclusion. An urgent paradigm shift is needed to transform urban areas from agglomerations oriented on motorized transport to ones that rely on active and sustainable mobility, in order to turn cities into places generating wellness and health.

Key words
- urban mobility
- urban health
- active mobility
- sustainable mobility
- motorized transport
- urban policy

INTRODUCTION

Nowadays city mobility is undoubtedly a driver of urban development and a key contributor to economic returns, as it facilitates economic competitiveness and social progress [1-3].

As a matter of fact, urban transport networks allow people to reach workplaces and public services, to satisfy citizen's needs, opportunities and social contacts as well as to take part in urban and social life. However, especially in metropolitan areas, mobility also has direct impacts on population's health, especially with regards to the use (and non-use) of motorized vehicles [1, 4, 5].

High-income countries have been economically and culturally dependent on motor vehicles as the primary means of urban mobility and this factor has heavily dominated urban planning and policy. Nevertheless,

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also in low-income countries, despite mass motorization started later, motorized transport represents a major risk for city's livability and Public Health [1, 5-7].

Air pollution, noise, greenhouse gases, green space impairment and urban heat islands together constitute traffic-related exposures, resulting in stressors both on population's health and on the environment [8, 9].

Cities are the largest producers of carbon emissions and energy consumption; in fact, they produce about 75% of CO2 emissions. In Italy in 2018, 87 out of 95 cities did not reach the annual target of 10 micrograms per cubic meter. In 2021, the latest WHO air quality guidelines strongly indicate halving the recommended level of exposure to ultra-fine PM2.5 particulate emissions related to combustion processes, from 10 micrograms per cubic meter to 5 micrograms per cubic meter [10-12].

In addition, mass motorization and the consequent associated lack of active movement reduce physical activity increasing sedentary behaviors [1, 13-15].

Moreover, current urban patterns, planning and policies are furthermore reinforcing the use of motorized transport for short-distance trips, exacerbating the effects described above [16, 17].

All these factors related to motorized transport are in turn associated with a significant burden of disease and increased premature mortality: for example, air pollution and sedentary lifestyle are associated with an annual 7 million and 2.1 million global deaths, respectively [1, 18].

Health impacts are significant in many cities, for example in Barcelona, Spain, where traffic related exposures and the lack of physical activity are responsible for nearly 3,000 premature deaths, 5,000 disease cases, and 50,000 disability-adjusted life-years (DALYS) [19, 20].

Transport planning and policy can affect human health through different pathways. Motor vehicles collisions have been associated with premature mortality, injuries, traumas and post-traumatic stress. Traffic related air pollution has been associated with premature mortality, cardiovascular and respiratory disease, lung cancer, diabetes, obesity, reduced lung and cognitive function in children, low birth weight, and premature birth. Noise has been associated with cardiovascular mortality and morbidity, annoyance and sleep disturbance, type 2 diabetes, high blood pressure in children, and reduced cognitive function in children. Heat islands have been associated with premature mortality, cardiorespiratory morbidity, hospital admissions, children's mortality, and hospitalization. The lack of green space has been associated with premature mortality, cardiovascular disease, poor mental health, poorer cognitive function, and behavioral problems in children. Sedentarism has been associated with premature mortality, cardiovascular disease, dementia, breast cancer, diabetes, and colon cancer. Climate change has been associated with extreme weather events, adverse effects on the ecosystem and species, sea level rise, thermal stress, premature deaths, illness and injury from floods, food poisoning, unsafe drinking water, changes in vector-pathogen host relations and in infectious disease geography/seasonality, impaired nutrition, adverse mental and physical health. Social exclusion and community severance have been associated with poorer mental health and well-being, premature mortality, lack of physical activity, and stress [1, 21].

So, investments in car facilities have led many cities and urban areas to a car-friendly development, encouraging the building of infrastructures such as roads networks and parking areas. These factors resulted in higher levels of air pollution, noise, heat island effects, less active travel and physical activity, and, in consequence, reduction of public spaces that can be used for other purposes such as green areas and public services for people's well-being [1, 22, 23].

In summary, urban and transport planning, environment exposures, physical activity, and human health are strictly linked.

The aim of this study was to analyze the relationship between citizens' characteristics and sustainable and active mobility behaviours through an online survey in 4 different Italian provinces.

MATERIALS AND METHODS

Study population

This study was conducted between October 2019 and February 2020 in the Provinces of Rome, Genoa, Milan and Palermo by the Working Group on Mobility and Health, National Advisory Body of Medical Residents in Public Health, Italian Society of Hygiene, Preventive Medicine and Public Health (SItI). The data collected anonymously was only accessible to the study researchers.

The questionnaire

An online multiple choice questionnaire was administered to the study population using Google Form. The survey took approximately 20 minutes to complete and investigated several aspects of mobility behaviours and respondents' characteristics (items shown in *Table 1* and *Figure 1*).

The link to the self-administered questionnaire was shared via social media (WhatsApp, Telegram, Facebook etc.) with a "snowball" effect (cascade effect that makes the participants themselves administrators). Questionnaires were completed anonymously after obtaining consent to process sensitive data for the study.

In order to allocate citizens in shared homogeneous groups with regard to living and working/studying places in cities, it was used the OMI (Italian Observatory of the Real Estate Market) classification.

The Italian Revenue Agency, in fact, has divided province capitals maps into bands which are indirect proxies of the socio-economic status of the citizens who live there.

The groups are "central", "semi-central", "peripheral", "suburban" and, for those who lived or studied/worked in the other municipalities of the province, "not in PC".

In order to analyze the relationship between food behaviors and sustainable and active mobility, it was used a synthetic numerical food score according to the model of the Mediterranean Food Alliance (https://oldwayspt.org/system/files/atoms/files/RateYourMedDietScore.pdf) in which higher values are proxies of healthy eating habits and high dietary variability.

Table 1
Characteristics reported by survey respondents

Number of respondents = 605	n (%) or Median (IQR)
Province	
Rome	154 (25.5%)
Genoa	168 (27.8%)
Milan	162 (26.8%)
Palermo	121 (20.0%)
Home location in PC	
Central	75 (12.4%)
Semi-central	234 (38.7%)
Peripheral	180 (29.8%)
Suburban	31 (5.1%)
Not in PC	85 (14.0%)
Work/study place location in PC	
Central	125 (20.7%)
Semi-central	307 (50.7%)
Peripheral	97 (16.0%)
Suburban	36 (6.0%)
Not in PC	40 (6.6%)
Educational level	
None or primary	1 (0.2%)
Lower secondary	5 (0.8%)
Upper secondary	143 (23.6%)
University degree	315 (52.1%)
Post-graduate degree	141 (23.3%)
Occupation	
Tradesman	8 (1.3%)
Public manager	43 (7.1%)
Policemen/firefighter etc.	7 (1.2%)
Employee/technical-administrative	198 (32.7%)
Freelance	105 (17.4%)
Workman/artisan	12 (2.0%)
Student	232 (38.3%)
Male gender	240 (39.7%)
Age (years)	29.0 (16.0)
BMI (kg/m²)	22.5 (4.1)
Food score	8.0 (3.0)
Smoking (past and/or present)	245 (40.5%)
LPA > 2 DPW	315 (52.1%)

PC: province capital; BMI: Body Mass Index; LPA: light physical activity; DPW: days per week.

Light physical activity indicates how often the respondent practices physical activity in his/her free time (walking for at least 1 km, soft gymnastics, etc.).

The five indicators of healthy (sustainable and active) mobility behaviours referred to the usual means of transport used to reach studying or working place. Public transport included bus, train, tram and metro.

Statistical analysis

Statistical analysis was performed using R 4.0.2 (released on 2020-06-22). Statistical significance α was fixed to 0.05.

Categorical variables were reported as absolute (n) and relative (%) frequencies. In order to account for non-normality, evaluated through the Shapiro Wilk test, numerical variables were reported as median and interquartile range (IQR).

In order to analyze the association between citizens' characteristics and healthy mobility indicators, 5 multiple binary logistic regression models were fitted with estimation of the odds ratios (OR) and 95% confidence intervals (CI).

The goodness of fit of the models was evaluated through the Hosmer-Lemeshow test.

RESULTS

Characteristics and healthy mobility indicators of the 605 respondents to the questionnaire were reported in *Table 1* and in *Figure 1*.

The majority of respondents were from Northern Italy (54.5%), lived in province capitals (86.0%), in particular in semi-central areas (38.7%), worked or studied in province capitals (93.4%), in particular in semi-central areas (50.7%), had a university or post-graduate degree (75.4%), were a worker (61.7%), were female (60.3%), weren't smokers at the time of the survey nor in the past (59.5%) and used to have light physical activities more than 2 days per week (52.1%).

Median (IQR) age was 29.0 (16.0) years, BMI (body mass index) 22.5 (4.1) kg/m² and food score 8.0 (3.0).

As far as healthy mobility indicators are concerned, 65.1% of respondents used the car less than 3 days per week, 83.3% used the motorbike less than 3 days per week, 43.8% used the public transport more than 2 days per week, 44.5% used to walk more than 2 days per week and 9.9% used the bike more than 2 days per week.

Results of multiple logistic regression models were reported in *Table 2*.

All models passed the Hosmer-Lemeshow goodness of fit test ($p>0.05$).

The variables positively associated with a frequency of car use lesser than 3 days per week were living, compared to Rome Province, in Milan Province (OR 2.16, 95% CI 1.20-3.95), being a student (OR 3.02, 95% CI 1.80-5.16), male gender (OR 1.69, 95% CI 1.10-2.60) and having light physical activity more than 2 days per week (OR 1.50, 95% CI 1.02-2.19).

The variables negatively associated with a frequency of car use lesser than 3 days per week were living, compared to Rome Province, in Palermo Province (OR 0.43, 95% CI 0.24-0.77), working/studying, compared to central area, in semi-central area (OR 0.52, 95% CI 0.29-0.91), suburban area (OR 0.19, 95% CI 0.07-0.50) and not in the province capital (OR 0.22, 95% CI 0.09-0.53), and BMI (OR 0.94, 95% CI 0.89-0.99).

The variables positively associated with a frequency of motorcycle use lesser than 3 days per week were

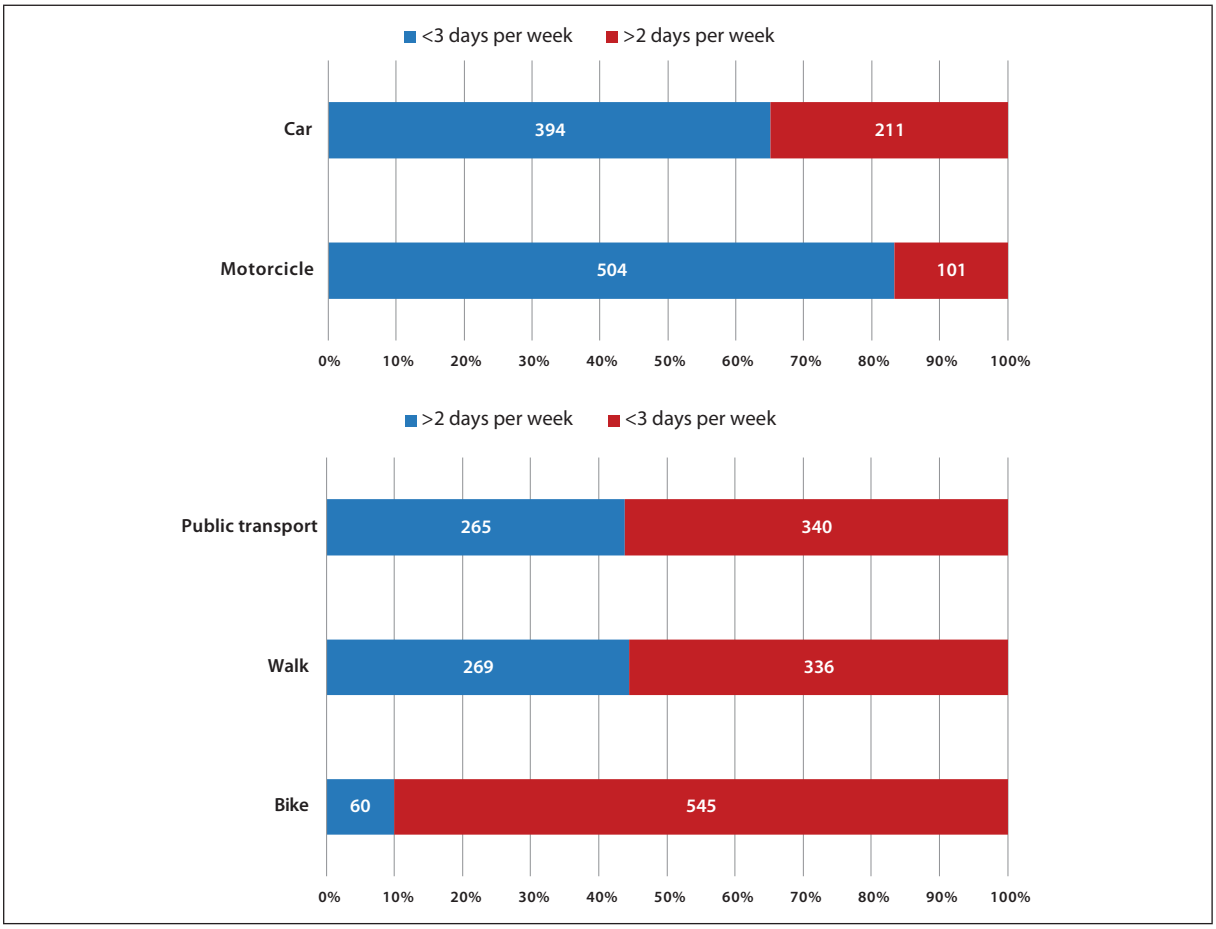

Figure 1
Healthy mobility indicators reported by survey respondents.

working/studying, compared to central area, not in the province capital (OR 7.25, 95% CI 1.33-135.60) and having light physical activity more than 2 days per week (OR 1.90, 95% CI 1.18-3.07).

The variables negatively associated with a frequency of motorcycle use lesser than 3 days per week were living, compared to Rome Province, in Genoa Province (OR 0.32, 95% CI 0.15-0.65) and male gender (OR 0.36, 95% CI 0.22-0.58).

The variables positively associated with a frequency of public transport use greater than 2 days per week were living, compared to central area, not in the province capital (OR 2.30, 95% CI 1.13-4.75), being a student (OR 2.13, 95% CI 1.36-3.36) and having light physical activity more than 2 days per week (OR 1.83, 95% CI 1.28-2.62).

The variable negatively associated with a frequency of public transport use greater than 2 days per week was living, compared to Rome Province, in Palermo Province (OR 0.29, 95% CI 0.16-0.53).

The variables positively associated with a frequency of walking greater than 2 days per week were being a student (OR 2.03, 95% CI 1.30-3.18) and having light physical activity more than 2 days per week (OR 2.25, 95% CI 1.58-3.22).

The variables positively associated with a frequency of bike use greater than 2 days per week were living, compared to Rome Province, in Milan Province (OR 10.19, 95% CI 4.00-29.18), male gender (OR 1.97, 95% CI 1.03-3.78), food score (OR 1.16, 95% CI 1.02-1.32) and smoking habits at the time of survey or in the past (OR 2.34, 95% CI 1.26-4.40).

DISCUSSION

The first interesting finding consists in the difference found among the scrutinized provinces in terms of sustainable and active mobility indicators, and the consequential effects on human health. In particular, living in the Province of Milan was associated with less car use and more bike use, while in Palermo there was a greater use of the car and a lesser use of public transport. It is therefore essential that all cities adopt solutions to encourage sustainable and active mobility, for example by increasing urban green spaces and implementing bikeways.

The home location did not seem to influence significantly mobility behaviours, with the exception of the greater use of public transport for those who did not live in the provincial capital. This could be linked to economic factors related to the lower cost of using public transport on extra-urban routes compared to the car.

Otherwise, working or studying in a central area was associated with less use of the car, while not working or studying in the province capital was associated with less

Table 2
Results of multiple binary logistic regression models for the five healthy mobility indicators (Hosmer-Lemeshow tests' p >0.05)

Number of respondents = 605	OR (95% CI)				
	Car <3 DPW	MC <3 DPW	PT >2 DPW	Walk >2 DPW	Bike >2 DPW
Province					
Rome	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Genoa	1.46 (0.81-2.62)	**0.32 (0.15-0.65)**	1.28 (0.76-2.17)	1.55 (0.92-2.64)	0.83 (0.26-2.72)
Milan	**2.16 (1.20-3.95)**	0.74 (0.34-1.58)	1.43 (0.85-2.41)	1.01 (0.60-1.72)	**10.19 (4.00-29.18)**
Palermo	**0.43 (0.24-0.77)**	0.70 (0.32-1.53)	**0.29 (0.16-0.53)**	0.66 (0.37-1.17)	0.57 (0.14-2.03)
Home location in PC					
Central	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Semi-central	1.37 (0.71-2.60)	0.82 (0.36-1.78)	1.74 (0.96-3.22)	1.04 (0.58-1.85)	2.40 (0.94-6.65)
Peripheral	1.00 (0.51-1.93)	0.90 (0.39-2.00)	1.57 (0.86-2.93)	0.88 (0.48-1.61)	1.23 (0.46-3.51)
Suburban	0.45 (0.16-1.24)	0.86 (0.23-3.70)	1.95 (0.74-5.19)	0.66 (0.25-1.71)	0.97 (0.05-6.74)
Not in PC	0.66 (0.31-1.39)	1.35 (0.49-3.82)	**2.30 (1.13-4.75)**	1.43 (0.71-2.87)	1.03 (0.28-3.61)
Work/study place location in PC					
Central	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Semi-central	**0.52 (0.29-0.91)**	0.93 (0.48-1.74)	0.75 (0.46-1.23)	0.72 (0.44-1.18)	1.76 (0.75-4.32)
Peripheral	0.57 (0.28-1.14)	0.87 (0.40-1.92)	0.87 (0.48-1.55)	0.93 (0.52-1.66)	0.83 (0.33-2.01)
Suburban	**0.19 (0.07-0.50)**	0.54 (0.19-1.57)	0.62 (0.25-1.50)	0.55 (0.22-1.32)	2.37 (0.45-10.28)
Not in PC	**0.22 (0.09-0.53)**	**7.25 (1.33-135.60**)	0.65 (0.29-1.47)	0.64 (0.28-1.45)	0.63 (0.16-2.14)
University or post-graduate degree	1.34 (0.85-2.12)	0.77 (0.43-1.33)	0.88 (0.57-1.37)	0.74 (0.48-1.14)	0.70 (0.32-1.61)
Student	**3.02 (1.80-5.16)**	0.90 (0.49-1.65)	**2.13 (1.36-3.36)**	**2.03 (1.30-3.18)**	0.73 (0.34-1.57)
Male gender	**1.69 (1.10-2.60)**	**0.36 (0.22-0.58)**	0.69 (0.46-1.02)	0.73 (0.49-1.07)	**1.97 (1.03-3.78)**
Age (years)	1.00 (0.98-1.02)	1.01 (0.98-1.04)	0.99 (0.97-1.01)	0.99 (0.97-1.01)	1.03 (1.00-1.06)
BMI (kg/m²)	**0.94 (0.89-0.99)**	0.94 (0.88-1.00)	1.04 (0.98-1.09)	0.96 (0.91-1.01)	0.90 (0.80-1.00)
Food score	1.07 (0.98-1.16)	1.03 (0.93-1.15)	1.00 (0.93-1.08)	1.01 (0.94-1.09)	**1.16 (1.02-1.32)**
Smoking (past and/or present)	0.90 (0.60-1.34)	0.78 (0.48-1.26)	0.70 (0.48-1.01)	0.80 (0.55-1.15)	**2.34 (1.26-4.40)**
LPA > 2 DPW	**1.50 (1.02-2.19)**	**1.90 (1.18-3.07)**	**1.83 (1.28-2.62)**	**2.25 (1.58-3.22)**	0.98 (0.53-1.82)

DPW: days per week; MC: motorcycle; PT: public transport; PC: province capital; BMI: Body Mass Index; LPA: light physical activity.

use of the motorbike. The first association is probably linked to zone-specific urban policy and city-planning factors, such as to the greater tendency of central areas of cities to be oriented towards sustainable and active mobility due to limited traffic areas and limited presence of parking lots. The second association is probably linked to the difficulty of traveling daily extra-urban routes by motorcycle.

For these reasons, the improvement, from a sustainable perspective, of our living, work, study and social life spaces in a sustainable perspective is an essential objective.

In Italy, many research works published by several experts related to the Italian Society of Hygiene and Preventive Medicine (SItI) and to European Public Health Association (EUPHA) contributed to the body of knowledge on the topic, confirming that good urban planning, improvement of road traffic, redevelopment of degraded and disadvantaged areas, and creation of green spaces, pedestrian and cycle paths appeared to be crucial elements in the development of resilient cities [24-26].

In particular, in the context of the research project titled "Urban Health: good practices for health impact assessment of urban and environmental redevelopment and regeneration interventions" and awarded by the Italian National Center for Disease prevention and Control (CCM) in 2017, the working group developed a multi-criteria, quali-quantitative assessment framework, capable of providing an effective and flexible support to the Local Health Agencies for evaluating the Urban Health strategies' integrations into urban plans. Specifically, the tool is composed by 20 criteria divided into 7 macro-areas: general criteria; environment; soil and subsoil; sustainability and hygiene of the built environment; urban and social development; mobility and transport; outdoor spaces [24, 26].

Another noteworthy finding of this survey is the fact that women reported greater use of cars and lesser use of motorcycles and bicycles. These gender differences could be linked to women's poor perception of safety in an open vehicle (motorbike or bicycle) compared to a closed private vehicle (car). This data highlights how the problem of sustainable mobility must be tackled in

a complex and articulated multidisciplinary perspective that also includes considerations of a social and cultural nature.

In the present work, age and educational level did not seem to be linked to the type of mobility, while being a student compared to a worker was related to lesser use of the car, a greater use of public transport and a greater tendency to walk to the work/study place. This data could be linked both to cultural and economic factors. An interesting fact, difficult to explain, was the association between smoking habits and use of the bike.

The positive relationships between BMI and car use, between food score and bike use, between frequent light physical activity and all healthy mobility indicators (except for the use of the bike) confirmed that risk factors are often interconnected and that improving even one single habit could have a positive effect on the others as well. Tackling these issues through Public Health measures, both with policy and health promotion interventions, could lead to great benefits in terms of human health.

In this sense, a winning strategy is certainly to promote a life-course health-oriented approach involving all possible stakeholders: e.g. the Italian National Prevention Plan for 2020-2025, like the previous one, has adopted an intersectoral approach which promotes multidisciplinary actions to change the determinants of health through health promotion and prevention policies [27].

Another key issue is to effectively deal with the problem of contemporary physical inactivity, which is a major Public Health problem. To this regard, transport planning has an important role in providing opportunities for active mobility physical activity: infact, encouraging people to use public transport, to walk and to cycle to study/workplace would make them physically more active and thus healthier as well as it would have positive environmental effects such as reducing their carbon footprint, local air pollution and noise levels [1, 23, 28].

Current transport practices produce unwanted side effects and adverse environmental exposures, while a more holistic approach to our cities could promote sustainable and active mobility and physical activity through Public Health oriented urban and transport planning and policies (mixed land use, greater street connectivity, street furniture, safe urban environments, pedestrian-friendly and cyclist-friendly amenities, free up public space) [1, 21, 29-31].

This study has some strengths and limitations. Firstly, given that it was used a self-administered questionnaire, there is a possibility of response bias in the participants' answers. Moreover, the questionnaire was administered to inhabitants of large Italian cities where journeys mostly take place by car to travel great distances, especially to go to work. On the other hand, a strong point was the ability to quickly send the questionnaire to many people via different platforms in different cities that are representative of different regions of the Country. To this regard, in the future it could be useful to extend this study to additional Italian cities and also to re-administer the questionnaire to the cities of this study to monitor the results over time, analyzing the impact of the COVID-19 upon urban mobility as well.

In fact, COVID-19 has brought to light a different approach to urban health, forcing the scientific community to analyze the impact of urban transport on human health in terms of both communicable and non-communicable diseases [32].

According to the UN, the environment around us can drastically affect our lifestyle habits. For this reason, the improvement, from a sustainable perspective, of our living, work and social life spaces is an essential goal. Urban Health strategies must be considered from the early stages of urban planning as a powerful tool for the prevention and promotion of human health [32, 33].

CONCLUSION

These results strongly confirmed the need to develop and implement urban policies in order to shift investments from car facilities to infrastructure for public and active transport, such as cycling infrastructures. These interventions can lead to an increased use of public and/or active transport, reducing air pollution, noise, heat island effects and stress. Moreover, public and/or active transport would increase physical activity, with a reduction in morbidity and premature mortality [22, 23].

As a matter of fact, cities represent the fulcrum for the implementation of policies oriented to sustainability and to effective responses to the challenges of climate change, urbanization and social inclusion. Good governance requires cooperation, sharing of knowledge and perspectives, and the creation of common agendas. Decision making can strongly influence citizens' choices, affecting both health and environment. Public health plays a big role in this process, as it can really make the difference through the development of effective health programs [34].

In conclusion, an urgent paradigm shift is needed to transform urban areas from agglomerations oriented on motorized transport to ones that rely on active and sustainable mobility, in order to turn cities into places generating wellness and health.

Conflict of interest statement

None.

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