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Self-assessment of health status and identification of traffic hazards for urban cyclists

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A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of the article

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Abstract

Introduction and Objective. The bicycle as a means of transport gains popularity among the inhabitants of European cities, being not only an alternative to cars, but also a way to improve health and wellbeing. The aim of the study is to identify and provide an in-depth analysis of health benefits, as well as potential environmental and traffic hazards resulting from regular commuting to work by bicycle.

Materials and Method. The study, conducted in the form of a diagnostic survey, included 285 adult inhabitants of Lublin, Poland. The criterion of purposive sampling was the respondents' occupational activity and choosing a bicycle as a means of commuting to the place of work. The study was carried out using an author-constructed questionnaire and a standardized research tool – Satisfaction with Life Scale. Statistical analysis was performed by means of $\chi 2$ test for independence; the p values $p \leq 0.05$ were considered statistically significant.

Results. Most respondents evaluated their overall health as good (55.4%) or very good (31.9%), and their self-assessed immune status as high (57.9%) or very high (23.5%). Year-round cycling was significantly associated with a higher self-assessment of health ($p<0.01$). Commuting by bicycle was associated with improved physical fitness (43.9%) and immunity (21.4%). Cyclists achieved a mean SWLS score of 23.4, indicating above-average life satisfaction. The main identified traffic hazards were cars/drivers (60%) and insufficient infrastructure (41.8%).

Conclusions. Regular commuting to work by bicycle is positively associated with perceived health benefits, including higher self-assessed fitness, higher self-assessed immune status, and fewer reported colds, as well as with above-average satisfaction with life. However, road safety concerns and insufficient cycling infrastructure remain significant barriers to active and safe commuting.

Key words

public health, transportation, bicycling

INTRODUCTION AND OBJECTIVE

Over the past decade bicycle traffic in European countries has been developing dynamically. The reason for this phenomenon concerns, among other things, the concern of inhabitants for a healthy and ecological lifestyle, increasingly modern cycling infrastructure, and the desire to move around the city more efficiently. Along with an increased number of bicycle lanes and safe parking spaces for bicycles, there also appeared many enthusiasts of using this means of transport for commuting to work.

Physical activity, referred to interchangeably as motor activity, is defined in the document *EU Physical Activity Guidelines* as: 'any bodily movement produced by skeletal muscles that requires energy expenditure exceeding resting levels'. This concept defines all forms of activities, starting with leisure activities (encompassing dancing and the majority of sport disciplines), and ending with professional sport, physical activity at home and in the surrounding area as well as activity related with transport [1].

The level of physical activity, to some extent, may become an objective determinant of the level of body fitness. Thus, while interpreting human physical activity, one may simultaneously draw conclusions about the level of this activity, and indirectly concern the state of health [2]. The response of the body to regular physical activity depends on many factors of which the most important are age, health condition of the person exercising, fitness, performance, training experience, or environmental conditions. An effective use of motor activity is associated with the need for assessment of an adequate number and frequency of exercises, or the intensity and type of the effort performed. It should be taken into account that an insufficient number of exercises may not produce the expected physiological effects, whereas an excessive number of training sessions inappropriate for age, individual advancement and performance, may be harmful to the body.

The comprehensive medical literature quite clearly confirms the positive effect of physical activity on human health. Numerous studies show that physical activity increases physical performance of the body, supports the process of treatment, enhances immunity, and reduces morbidity due to many disease entities [3–6]. However, synthetizing the research findings from various studies concerning aspects of physical activity is quite complicated, because the researchers usually use various means of measurement [7]. Some scientific studies focus on the analysis of the effect of cycling on cyclists' health. According to comprehensive meta-analysis of data persons who use a bicycle instead of a car for daily commuting to work, this considerably prolongs their lifespan and reduces the risk of premature death [8–10].

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Recent comprehensive reviews and health impact assessments confirm that the health benefits resulting from short bicycle trips outweigh the risks related to air pollution and accident rates. Although the examined doses of polluted air were slightly higher while cycling than while driving a car, and the risk of fatal accidents also more often concerned bicycle riders, health benefits definitely dominated this comparison, manifesting themselves primarily by lower mortality due to cardiovascular diseases [11]. Large-scale prospective studies demonstrated that regular cycling (e.g. while daily commuting to work) considerably reduced the risk of the occurrence of depression and anxiety disorders, exerting a positive effect on the overall state of psychological health [12].

It should be kept in mind that an increased physical activity, including cycling in urban conditions, brings many hazards, e.g. traffic accidents, exposure to polluted air or noise, which may lead to injuries or respiratory diseases, including lung cancer [8, 11]. Nevertheless, the majority of scientific studies do not focus on both the positive and negative aspects of cycling, but usually concentrateonly on benefits resulting from such commuting [3, 10]. Recent studies from various European countries emphasize that the health benefits of everyday cycling exhibit a dose-response relationship, where greater frequency of active commuting yields more pronounced improvements in health parameters [9, 10]. Furthermore, international research highlights the necessity of understanding perceived risks, such as traffic safety and infrastructural barriers, directly from the cyclists' perspective, as these factors significantly determine the choice of active transport [1, 8].

Therefore, it seems justifiable to conduct research in which cyclists themselves would be able to identify and assess health aspects resulting from commuting to work by bicycle. The aim of the study was to identify and provide an in-depth analysis of health benefits, as well as potential environmental and traffic hazards resulting from regular commuting to work by bicycle.

MATERIALS AND METHOD

The study was conducted during 2020–2022 in Lublin, Poland, using the following research tools: an author-constructed questionnaire and the standardized Satisfaction with Life Scale (SWLS) [13]. The author-constructed questionnaire was developed based on a review of current literature concerning cycling determinants. For the SWLS, formal permission for its use was obtained from the author of the Polish adaptation. Due to the fact that the study was quantitative, and the examined population had specific characteristics, purposive sampling was applied. Data were collected using a mixed-mode approach: both traditional paper-and-pencil interviewing (PAPI) and computer-assisted web interviewing (CAWI). Participation was voluntary and anonymous, and no exclusion criteria regarding the participants' level of education were applied. From the study were excluded inhabitants of cities other than Lublin, persons occupationally inactive, those who did not use a bicycle as a means of commuting to work, who did not express their consent for participation in the study, as well as persons under the age of 18.

The questionnaire was pilot-tested on a group of 10 cyclists to ensure the clarity and comprehensibility of the questions prior to commencement of the main study. The Body Mass Index (BMI) was calculated by the author based on the participants' self-reported height and weight. The results obtained were statistically analyzed using Statistica software. The data was analyzed using the methods of descriptive statistics, while calculation was performed by means of $\chi 2$ tests for independence. The p values $p \leq 0.05$ were considered statistically significant.

RESULTS

The study group included 285 participants, the majority were males (58%), and a slightly lower percentage of females (42%). Table 1 presents demographic characteristics of the study sample.

Table 1. Demographic characteristics of the study sample

Variable	Category	n (%)
Gender	Male	164 (58.0%)
	Female	121 (42.0%)
Age	20–30 years	52 (18.0%)
	31–40 years	119 (42.0%)
	41–50 years	84 (29.0%)
	51–60 years	19 (7.0%)
	≥ 61 years	11 (4.0%)
Education	Higher	211 (74.0%)
	Secondary / Post-secondary	65 (22.8%)
	Vocational	9 (3.2%)
Material standard	Very good	22 (7.7%)
	Good	129 (45.3%)
	Mediocre	127 (44.6%)
	Poor	7 (2.4%)
Occupation	Office work	203 (71.2%)
	Physical work	64 (22.5%)
	Both (office and physical)	10 (3.5%)
	Other	8 (2.8%)

Analysis showed a significant relationship between education and age (χ^2=21.03; p=0.00706), with higher education being most prevalent among cyclists aged 31–40. Furthermore, a significant association was observed between material standard and age (χ^2=26.10; p=0.01039), the youngest and oldest respondents most frequently reported a mediocre material standard, whereas those aged 31–40 predominantly declared a good financial situation.

Regarding commuting habits, the vast majority of respondents declared that they use a bicycle as the means of transport four or five times a week (41.4%). Nearly half as many respondents (21.8%) used the bicycle two or three times a week, 18.2% of respondents commuted to work by bicycle several times a month, whereas 12.3% – more often than five times a week. 44.6%) of females most frequently commuted to work by bicycle four or five times a week while 39% of males did so. Similar percentages of males and females commuted to work several times a month (18.9% and 17.4%, respectively); in turn, 14.6% of males and 9.1% of females commuted by bicycle more often than five times a week.

Maintenance of proper body weight is an important element deciding about the state of health of an individual. The current study demonstrates that the Body Mass Index (BMI) among the examined cyclists remained within the range of normal body weight – 24.76 scores, on average. The minimum indicator of underweight was 17.75, whereas maximum indicator equivalent to severe obesity was 41.35.

Among males, the mean BMI was 25.82, thus indicating overweight, while in females this result was 23.34 – normal body weight.

Self-assessment of the state of health. More than a half of respondents (55.4%) evaluated their state of health as good, and 31.9% as very good (Fig. 1). Males slightly more often considered their state of health as very good (34.1%), compared to females (28.9%).

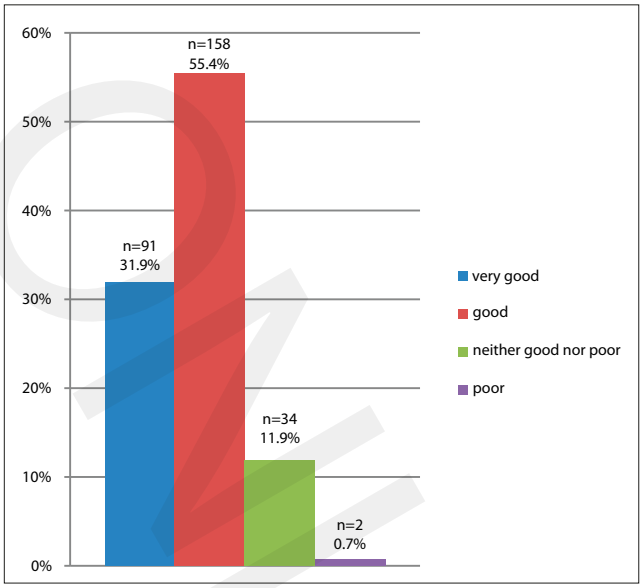

Figure 1. Respondents' self-assessment of the state of health (n=285)

The majority of respondents commuting to work by bicycle (also in winter) described their state of health as very good (45.5%) or good (42.9%). The majority of respondents who did not commute to work by bicycle in the winter season evaluated their state of health as good (63.6%), while only 23.1% as very good. This relationship was statistically significant (χ^2=16.29; p=0.00099).

The respondents were asked to assess their immune status. More than a half of the cyclists evaluated it as high (57.9%), and nearly one-fourth (23.5%) – as very high. Males more frequently assessed their immune status as very high (26.2%), compared to females (19.8%); however, it was different in the case of indicating the answer 'mediocre immunity', which was more often indicated by females (21.5%) than males (14%) (Fig. 2).

The analysis also included the association between the respondents' self-assessed immune status and state of health.

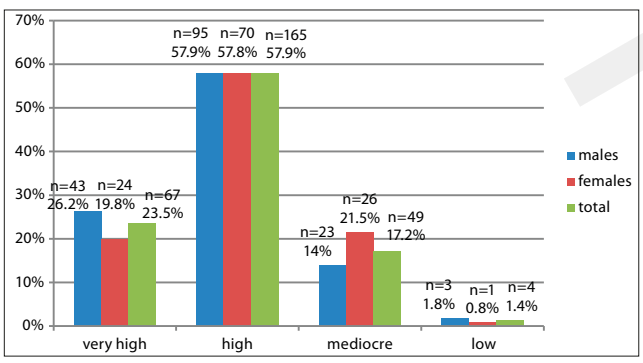

Figure 2. Distribution of the respondents' self-assessed immune status (n=285)

The replies obtained demonstrated that persons who declared a very good state of health more frequently assessed their immune status as very high (54.9%), whereas the vast majority of those who evaluated their health as good defined their immunity as high (70.9%). This relationship was statistically significant (χ2=131.11; p=0.0001). A statistically significant relationship was also observed between the number of colds and self-assessment of the state of health (χ2=107.55; p=0.00001), which clearly indicated that the higher the evaluation of the state of health, the lower number of colds.

A very high self-assessed immune status was most frequently declared by persons who cycled regardless of the weather (13%), whereas high immunity was most often mentioned by respondents who commuted to work by bicycle only when there was no precipitation (29.8%). The data showed that persons who chose to cycle only in sunny and warm weather most rarely declared high self-assessed immune status (Fig. 3).

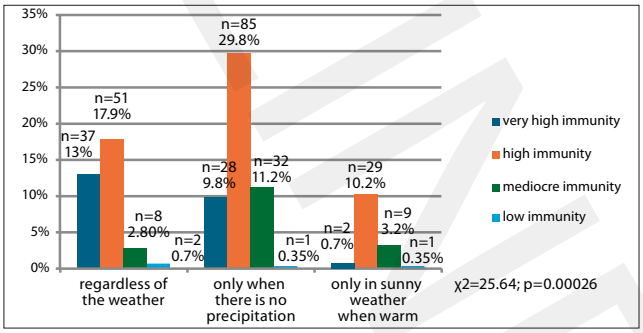

Figure 3. Self-assessed immune status and type of weather during which respondents commuted to work by bicycle (χ2=25.64; p=0.00026; n=285)

The cyclists declared one cold annually, on average, and nearly one-fifth of respondents (17.5%) did not fall ill at all. A statistically significant relationship was observed between the number of colds and self-assessment of health ($p<0.05$). Persons who commuted to work by bicycle were on sick leave for 3.6 days, on average – females – for 4 days, on average, whereas males – for 3.3 days annually.

The cyclists definitely indicated that commuting to work by bicycle exerts a beneficial effect on their overall state of health. More than a half of them (53.3%) defined this effect as very positive, 41% as positive, while only 3.1% considered that commuting by bicycle has no effect on their health. None of the respondents provided the answer that this form of transport has a negative or very negative effect on their health (Fig. 4). Both males and females replied similarly, and the relationships between gender (χ2=0.037; p=0.99815), education (χ2=8.52; p=0.20245), or age (χ2=16.73; p=0.16017), and the overall state of health were statistically insignificant.

The respondents who evaluated commuting to work by bicycle on their state of health in positive terms most often indicated a positive effect on the following aspects: physical fitness (43.9%), self-assessed immune status (21.4%), respiratory capacity (17.9%), or overall physical performance (17.5%). The cyclists more rarely mentioned, among other things, positive effect on the spine (6.7%), reduction of stress (4.6%), or improvement of the body shape (3.5%). Figure 5 presents all health benefits mentioned by the respondents.

Respondents' satisfaction with life. Apart from physical and social wellbeing, the state of health of an individual

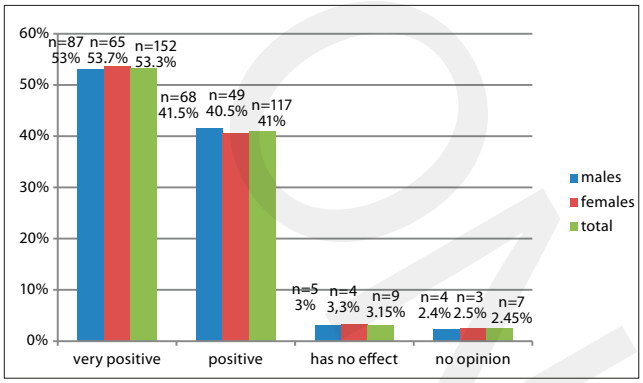

Figure 4. Perceived effect of commuting to work by bicycle on the overall state of health (n=285)

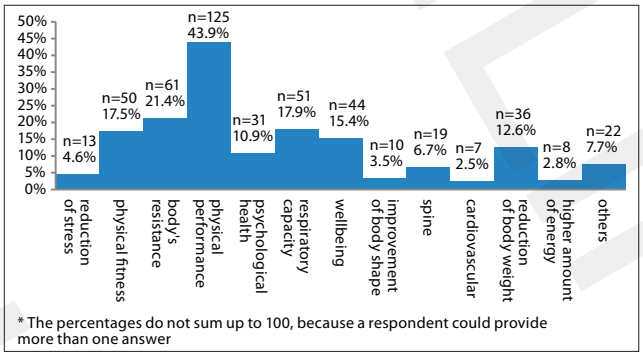

Figure 5. Commuting to work by bicycle and its perceived beneficial effect on health (n=285).

is an important element. One of its aspects is satisfaction with life. In order to assess the cyclists' satisfaction with life the Satisfaction with Life Scale (SWLS) was applied, which included five issues. During the study, the respondents evaluated according to the scale from 1–7, to what extent each question refers to their to-date life. The result of the measurement is an overall indicator of the feeling of satisfaction with life.

The respondents' evaluations were summed-up, and the overall result defined the degree of their satisfaction with life within the scale of 5 – 35 scores. The higher the result, the higher satisfaction with life. Among the examined cyclists the arithmetic mean of summed-up answers according to the Satisfaction with Life Scale was 23.4 scores. Analysis according to gender did not demonstrate any significant differences in the results between males and females, the mean was over 23 scores. In Polish studies in general, this mean among adult males and females the score was 20.37; thus, the result obtained among cyclists in the study may be considered as relatively high. Considering sten scores, according to the temporary Polish standards, the raw result within the range 21–23 scores means 6 stens. The results within the range 5–6 stens are considered as mediocre [13].

Identification of traffic and environmental hazards on the way to work. When asked about traffic and environmental hazards identified on the way to work the cyclists most often indicated threats caused by cars and vehicle drivers (60%), followed by the issue of insufficient infrastructure (41.8%), danger posed by pedestrians (22.8%), the risk of being struck by a vehicle, accident or the resulting injuries (17.2%), and air pollution (15.8%). A relatively small group of respondents

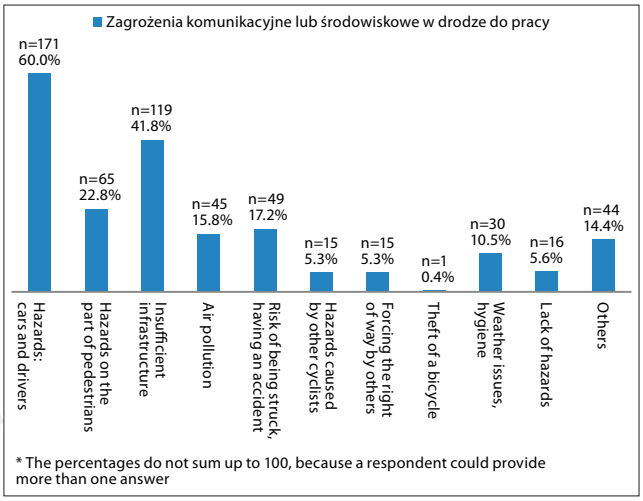

Figure 6. Traffic and environmental hazards on the way to work (n=285)

(5.6%) declared that they did not identify these types of hazards (Fig. 6).

The study also focused on the reasons due to which the examined persons would give up commuting to work by bicycle. As the main reason for such potential resignation the respondents indicated primarily changeability of weather conditions, as well as possible injuries or contusions (46.3% each, respectively), followed by colds (34.4%), insufficient cycling infrastructure (18.3%), or traffic hazards (17.5%). A relatively large part of the respondents (24.2%) did not consider giving up commuting to work by bicycle at all (Fig. 7).

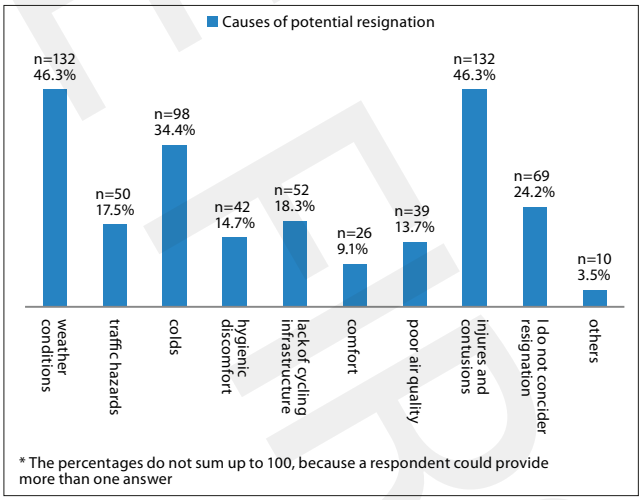

Figure 7. Potential resignation from commuting by bike according to reasons (n=285)

DISCUSSION

Despite dynamic changes and investments taking place in urban infrastructure, comparative analyses of transport systems confirm that adequate infrastructure is crucial to stimulate an increase in the number of cyclists [14]. Population studies confirm that active transport, especially cycling, exerts a considerably more positive effect on physical and psychological health, compared to other means of transport [15, 16]. In addition, regular physical activity, such

as cycling, plays a key role in the prevention and treatment of many disorders, including disorders of the cardiovascular system [17]. Moreover, short, intensive training sessions are characterized by higher effectiveness in the improvement of mental functions and normal functioning of neurons, compared to long-lasting, but less intensive efforts [18, 19].

According to the literature, in the case of persons who changed from commuting by car to commuting by bicycle for short distances, the beneficial effect of increased physical activity was considerably greater (relative risk 0.50–0.90) than the potential effect of mortality caused by increased doses of inhaled air pollutants (relative risk 1.001–1.053), or traffic accidents (relative risk according to age 0.993–1.020). The estimated increase in life expectancy *per capita* as a result of an increase in physical activity ranged from 3–14 months [8]. These calculations are confirmed by contemporary research using advanced models of the assessment of the effect on health. The latest scientific reports confirm that health benefits from active transport outweigh by many times the risk related with air pollution or traffic accidents [20, 21].

The majority of the cyclists examined for the purpose of this study assessed their health and immune status in positive terms. More than a half of respondents described their health condition as good or very good, while nearly 60% of them defined immunity as high or very high. It is worth paying attention to the relationship between self-assessment of health/immunity and the number of colds – persons who highly evaluated these aspects actually fell ill less often. Analysis showed that commuting to work by bicycle is perceived by the respondents as a factor positively affecting their health, especially regarding physical fitness, immunity, and respiratory capacity.

Scientific reports indicate that regular cycling can also result in improvement in the level of satisfaction with life and reduced level of stress [22, 23]. Based on the international interpretation of SWLS [13], the result of satisfaction with life among the examined cyclists remained within the range 20–24, which means a mediocre evaluation. The mean satisfaction with life, especially in economically developed countries, is within the above-mentioned range. The majority of persons with this result were satisfied with life, although there are certain areas which they would like to improve. Some respondents who obtained a result within the range 20–24 were satisfied with the majority of the spheres of their life, but they also perceived the need for improvement in each of these areas. Other respondents obtained similar results within this range, because they were satisfied with the majority of domains of their life. However, there were individual areas where they would like to see significant improvement.

In the presented study the cyclists could identify the key traffic and environmental hazards to which they were exposed while commuting to work. They most often indicated threat caused by cars/vehicle drivers, and shortages in the cycling infrastructure. Attention was also paid to the fact that a noticeable part of them signalled the problem of air pollution. This is an important aspect which should be taken into account in the transport policy of the cities. It is also worth noting that the respondents could potentially resign from commuting to work by bicycle, not only because of adverse weather conditions, but also the risk of injuries or potential colds, which makes the overly idealistic image of this means of transport more realistic.

The presented study demonstrates that commuting to work by bicycle brings many health benefits, starting from the improvement of physical fitness, and ending with the feeling of satisfaction with life. Simultaneously, the cyclists are aware of threats that they have to face on the road.

Limitations of the study. The main limitation is its cross-sectional character and basing the results exclusively on the subjective declarations of the respondents, without biomedical measurements. This was due to financial and organizational constraints. The second limitation was that a self-selection bias may be present; although no educational exclusions were applied, the sample predominantly consisted of individuals with higher education, who generally reported better health literacy and living conditions. Moreover, commuting by bicycle inherently requires a baseline level of physical fitness. This phenomenon, recognized in the literature as the *healthy cyclist* or *healthy commuter effect* [24, 25], implies that those who are already healthier and fitter are more likely to choose and sustain active commuting.

Additionally, the study was conducted during the COVID-19 pandemic (2020–2022), a period characterized by exceptional population mobility patterns and health contexts. These pandemic-related contextual factors might have influenced commuting behaviours and stress levels, potentially limiting the strict generalizability of the findings to non-pandemic conditions. The continuation of this research project could include physiological indicators together with multi-factor analysis, which would allow a more precise assessment of the relationship between commuting to work by bicycle and health.

CONCLUSIONS

1. The study results suggest a positive association between regular commuting to work by bicycle and higher self-rated physical and psychological health, particularly regarding self-assessed fitness and self-assessed immune status.
2. The majority of the respondents evaluated their state of health as good or very good, and the number of colds was inversely associated with self-assessed health.
3. Persons commuting to work by bicycle had an above average indicator of satisfaction with life.
4. The main traffic hazards include risk caused by road traffic and insufficient infrastructure.

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