doi: 10.15678/ZP.2021.58.4.04

Zarządzanie Publiczne
Public Governance
No. 4(58)/2021
ISSN 1898-3529

Stanisław Wieteska, Maria Węgrzyn, Małgorzata Jeziorska

Sleep Disorders as a Safety Issue in Transport and Communication Largely Not Appraised by National Health Policies

Abstract

Objectives: The objective of this article is to present the issue of sleepiness, sleep disorders, and their impact on traffic safety in Poland. The paper reviews published studies and data concerning the causes of driver fatigue and the scale of the sleep-related road accident problem.

Research Design & Methods: This paper uses an extensive analysis and study of literature, classification, and scientific description,

Findings: Road traffic accidents represent a huge public health concern, which needs to be tackled by a multi-disciplinary approach. Related deaths and disabilities have social and financial consequences, and are a real public health challenge. Sleep disorders have a tangible and empirically-proven effect on road safety. Effective identification, organised response, and therapy of this type of disorders should be implemented.

Implications / Recommendations: The realisation of healthcare needs and services provided by the state can only be obtained under conditions of properly organised and operationally-effective economic, political, and social systems. A proper understanding of mechanisms and factors responsible for hazardous road behaviour may be of practical use for many actors involved, including public services, the healthcare sector, road safety services, road and vehicle engineers, and the financial sector, primarily insurance companies.

Contribution / Value Added: As a result of the analysis, the synthesis of the theoretical findings on the road safety was presented. The certain consequences for national health policies were mentioned. This paper may serve as a basis for establishing subsequent empirical studies.

Keywords: sleep disorders, drowsy driving, road safety, economic consequences of road traffic accidents, health policy

Article classification: research article

JEL classification: H5, H8, M21, G22

Stanisław Wieteska – Professor emeritus of the University of Lodz, Faculty of Economics and Sociology, University of Lodz; 3/5 POW Street, 90-255 Lodz; ORCID: 0000-0002-6578-9861. **Maria Węgrzyn** – Wroclaw University of Economics and Business; 118-120 Komandorska Street, 53-345 Wrocław; e-mail: maria.wegrzyn@ue.wroc.pl; ORCID: 0000-0002-5063-9238. **Małgorzata Jeziorska** – Faculty of Economics and Sociology, University of Lodz; 3/5 POW Street, 90-255 Lodz; e-mail: malgorzata.jeziorska@uni.lodz.pl; ORCID: 0000-0001-8364-7106.

Introduction

The realisation of healthcare needs and services provided by the state can only be obtained under conditions of properly organised and operationally-effective economic, political, and social systems. Public health care, as an integral element of such systems, reflects social policies of the state and, in effect, decides upon the quality of public health in populations covered by the service. Three major directions of social policy involvement can be observed in this respect: the organisation and operation of the public healthcare system, lifestyle concerns, and the protection of natural environment.

As any other national system, public health care system is designed to respond to healthcare needs of specific populations, while the factual character and extent of such needs – confirmed by analyses of consumer behaviours in relation to the quality and quantity of rendered services – is determined by a wealth of other elements, particularly by the availability of resources held by the system as well as the system's capacity for accurate identification of such needs. Not all of them are properly reflected despite their confirmed negative effect on public health, as attested by the lack of policy measures for the identification and treatment of sleep disorders among drivers and machine-operators. Sleep disorders are confirmed to have a major effect on road accidents and should be regarded as a major cause of deaths and crippling injuries.

Sleep is a basic physiological need; humans devote almost a third of their lives in pursuit of it. General knowledge of the importance of sleep and of its role in maintaining good health and mental condition is still inadequate, as is the knowledge of methods used in therapy of sleep disorders (Wichniak & Poradowska, 2017). For this reason, causes and consequences of sleep disorders have become a major topic of public interest in many societies. Within the last few decades, sleep medicine has evolved to a status of a distinct medical subspecialty. Proper balance between sleep and daily activities is a determinant of the quality of life and occupational practice. Hence, good understanding of the sleep-related mechanisms and factors that may affect human behaviour, including road behaviour in drivers, is of paramount importance in many disciplines, such as medical science, psychology, and engineering (Biernacki, 2017).

Most of the sleep-related traffic accidents occur at standard driving conditions, often on straight sections of the road. Under the Polish law, these are described by official causes as falling asleep at the wheel or driver fatigue. Under the formal structure of classification, falling asleep at the wheel ranks at the rear of the list of major causes of road accidents. It must be noted, however, that drivers are often incapable of predicting and foretelling the incidence of sudden spells of tiredness or falling asleep while driving. Falling asleep at the wheel poses an extreme danger for all road-users, with the additional risk of major material damage, and often deaths.

The objective of this article is to present the issue of sleepiness, sleep disorders, and their impact on traffic safety in Poland. Drowsy driving is dangerous and leads to thousands of deaths and injuries on Polish roads. This paper reviews published studies and data concerning the causes of driver fatigue and the scale of the sleep-related road accident problem. Research methods used in this article include the analysis of official documents, current scientific literature, and secondary data.

The article consists of five parts. The first part is an introduction. The second one presents literature review and theory development of sleepiness, sleep deprivation, and the impact of sleep disorders on road safety. In the next part, the material and the methods are presented. Discussion on road safety in Poland is investigated in the fourth section. Concluding remarks and recommendations for further research and public health policies are presented in the fifth part of the article.

Sleepiness, sleep deprivation, and sleep disorders

Sleep is a complicated physiological phenomenon, essential for a normal, healthy functioning of the human body. It is not a matter of choice; it is essential and inevitable. Sleep deprivation impairs cognitive functions, and its long-term deficiency can even lead to death. Sleep cycle can be divided into two basic categories: non-rapid eye movement (NREM) and rapid eye movement (REM). During the NREM period, four separate stages can be distinguished. The final stage of non-REM sleep is called 'deep sleep'. Maintaining the proper architecture of sleep, and especially the presence of 'deep sleep', is necessary for the proper functioning of the body (Pływaczewski et al., 2013). Experts recommend that adults should sleep for 7–9 hours per day to promote optimal health (Watson et al., 2015; Hirshkowitz et al., 2015). Nowadays, many people sacrifice sleep in favour of other activities during the day. They borrow from sleep time to meet the demands of everyday life (Barnes et al., 2012). The loss or disruption of sleep may lead to sleepiness during periods of activity. According to the *American Academy of Sleep Medicine*, sleep deprivation occurs when an "individual fails to get enough sleep". Among the main causes of chronic sleep deprivation, those which stand out are medical problems, work hours, and other personal obligations restricting sleep time (American Academy of Sleep Medicine, 2008). Sleep deprivation can affect both women and men. They are spotted in mature people, but also in children and adolescents. After poor sleep, the human body can display a range of negative conditions, including cardiovascular disorders, shifts in body temperature, decreased concentration, impaired perception, memory lapses. Malaise is typically present, and the ability to perform is decreased in terms of both accuracy and speed. Every effort is exhaustive and serves as cause for irritation.

The first major classification of sleep disorders, the Diagnostic Classification of Sleep and Arousal Disorders, was published in 1979. It was thoroughly updated in 1997 (ICSD-1, published by the American Academy of Sleep Medicine). The second edition of that classification (ICSD-2) was published in 2005, and the third one (ICSD-3) was released in 2014.

The effective development of sleep studies and the apparent need for this type of involvement has also been reflected in Poland, stimulating a rapid increase of institutions and other bodies active in the field of sleep disorder research. The Polish Sleep Research Society was established in 1994 and the Sleep Apnea Syndrome Section of the Polish Physiopneumological Society was founded in 1996.

The International Classification of Sleep Disorders (ICSD-3) includes seven major categories of sleep dysfunctions (Sateia, 2014):

- insomnia;
- sleep-related breathing disorders;
- central disorders of hypersomnolence;
- CRSWDs;
- sleep related movement disorders;
- parasomnias;
- other sleep disorders.

Insomnia is defined as "a complaint of trouble initiating or maintaining sleep which is associated with daytime consequences and is not attributable to environmental circumstances or inadequate opportunity to sleep" (Sateia et al., 2017). The ICSD-3 classifies insomnia into acute or chronic based on the criterion of duration. When the disorder lasts at least 3 months and at least three times per week, it is identified as chronic (Sateia, 2014). Otherwise, it is considered as acute. Acute insomnia is not a medical condition, but a physiological reaction (Szelenberg, 2003).

Depending on the clinical picture or pathological mechanism, insomnia can be divided into the following subtypes (Avidan & Neubauer, 2017):

- psychophysiological insomnia (behaviourally-based);
- adjustment insomnia (occurs in temporal association with an identifiable stressor);
- paradoxical insomnia (reflects a complaint of severe sleep disturbance in the absence

of corroborative and objectively-verifiable indicators of the degree of sleep disturbance claimed by the patient);
- idiopathic insomnia (unrelated to an identifiable precipitant that begins insidiously in childhood and continues chronically in an unremitting pattern into adulthood);
- insomnia due to inadequate sleep hygiene;
- insomnia due to a mental disorder and insomnia due to a medical condition;
- insomnia due to a drug or substance.

A thorough overview of insomnia from a medical perspective can be found in Michael J. Sateia and Peter D. Nowell's (2004) expansive study of causes and effects of insomnia, complete with evaluation of therapeutic methods.

The development of research on the issue of insomnia has led to the conclusion that circadian rhythms are very important for the sleep quality. Circadian rhythm is one of the primary mechanisms influencing the length, quality, and time of sleep. Long persistence of these dysfunctions leads to a severe impairment in physical health and social functioning (Wichniak et al., 2017a).

Human bodies operate on the basis of an internal biological clock, which regulates the course of many physiological processes. We talk about circadian rhythm sleep-wake disorders (CRSWD) when there is a significant failure to adjust the patient's internal rhythm to social expectations. The origins of CRSWD may be endogenous or exogenous. Endogenous disorders include:
- delayed sleep-wake phase disorder;
- advanced sleep-wake phase disorder;
- non-24-hour sleep-wake rhythm disorder;
- irregular sleep-wake rhythm disorder.

Among exogenous disorders, the following ones are distinguished (Wichniak et al., 2017b; Sateia, 2014):
- dysfunction associated with shift work;
- jet lag disorder.

A large group of disorders are also those associated with the process of breathing during sleep. According to ICSD-3, sleep-related breathing disorders are divided into four sections: obstructive sleep apnea (OSA), central sleep apnea (CSA) syndromes, sleep-related hypoventilation disorders, and sleep-related hypoxemia disorders. Breathing disorders during sleep often coexist with lung diseases (Sateia, 2014). On average, bouts of sleep apnea and periods of shallow breathing last ca. 10 seconds, and the intensity of this disorder is measured by their per-hour incidence.

The most common sleep apnea is the obstructive sleep apnea (OSA). The OSA is a chronic disorder characterised by repetitive episodes of nocturnal breathing cessation due to upper airway collapse. It is characterised by repetitive episodes of complete or partial collapse of the upper airway during sleep, with a consequent cessation or reduction

Table 1. The most typical symptoms of the obstructive sleep apnea syndrome (OSAS)

Nocturnal symptoms	Waking hours symptoms
– loud snoring;	– doziness and sleepiness at daytime;
– episodes of sleep apnea observed by others;	– falling asleep during monotonic activities;
– sleep fragmentation (frequent wake-ups);	– waking up with a feeling of tiredness and fatigue;
– profuse sweating;	– the sense of inadequate sleep;
– muscle (movement) agitation;	– morning headaches;
– periods of dyspnea (shortness of breath) during sleep;	– irritability;
– stenocardia (angina pectoris).	– disturbed concentration;
	– potency disorders.

Source: Own elaboration based on: Kiciński et al., 2012; Taźbirek et al., 2016.

of the airflow. The OSA is associated with a significant cardiovascular morbidity and mortality, and causes excessive daytime somnolence (Spicuzza et al., 2015). Table 1 presents a list of the most typical OSA symptoms.

The OSA is important from the perspective of public health; people with an untreated OSA have higher rates of health care use. Among individuals with an OSA, unintentional injury rates are also higher. Higher rates of motor vehicle collisions and work-related injuries add to the public health burden (Semelka et al., 2016). The 'sleep architecture' of persons afflicted by an OSA is so unstable that it affects the natural rhythm of their waking hours. This, in turn, further affects their concentration and performance.

The impact of various sleep disorders on the number of traffic accidents was confirmed by numerous studies. Effective treatment of patients with these conditions can reduce the road mishaps.

Two groups of fatigue causes can be identified:

- task-related (lack of sleep or poor sleep, time-on-task, monotonous tasks);
- individual characteristics including medical conditions (internal body clock, age, gander).

Among the symptoms of fatigue, the following can be distinguished (European Commission, 2018):

- muscle fatigue related to static load;
- sensory fatigue, or decreased perception and reaction time;
- mental fatigue, or a limitation of cognitive functions;
- emotional fatigue produced by stress factors.

Almost 30% of drivers experienced almost falling asleep at the wheel (Maycock, 1996). Nearly 19% of the subjects experienced near misses due to falling asleep at the wheel and 1,3% experienced an accident (Powell et al., 2007). Surveys reveal that excessive sleepiness is involved as a contributing factor in 5–7% of all road accidents (17% when accidents involved fatalities) (Tefft, 2012). The traffic accident risk with respect to a reference population varies between two- and seven-fold in different surveys (sometimes the results differ because of methodology) (Lyznicki et al., 1998; McNicholas & Rodenstein, 2015). Effective treatment of sleep disorders can result in substantial decreases of the motor-vehicle accident risk. This again seems to emphasise the urgency of the proper diagnostic and therapeutic procedures to reduce potential public safety risks. An effective therapy seems fairly obvious and rational not only for the afflicted people, but also for other participants of the economic and social life.

The high prevalence of undiagnosed sleep disorders requires an easy-to-use screening tool. One of the effective and reliable tools can be the Epworth Sleepiness Scale (ESS) (Johns, 1997). This scale measures the ease of falling asleep. The respondent answers the questions of how high the probability of falling asleep in specific situations has recently been. The ESS asks the respondent to rate on a 4-point scale their usual chances of having dozed off or fallen asleep while:

- sitting or reading;
- watching TV;
- sitting inactively in public places (e.g. theatre, cinema, meeting);
- riding a car (as a passenger);
- lying down to rest in the afternoon when circumstances permit;
- sitting and talking to someone;
- sitting quietly after a lunch without alcohol;
- being stuck at a traffic jam.

A double-digit value should be alarming. Another simple screening tool is the STOP-Bang questionnaire (Chung et al., 2008). The questionnaire includes eight yes/no questions related to snoring, tiredness, observed breathing cessation, high blood pressure, BMI, age, neck circumference, and gender. After identifying a subset of the population at risk, additional testing should be performed.

The argument of being diagnosed with a sleep disorder cannot be brought forward as a reason for precluding the patient from vehicle use. It should only serve to persuade the patient to seek assistance from the specialists in order to obtain help in limiting the negative effects of this condition.

However, diagnoses of sleep disorders in Poland are fairly infrequent, as patients themselves rarely perceive their sleep disorders as a medical condition. Patients are not sufficiently aware of the relationship between sleepiness, sleep deprivation, sleep disorders, and road traffic accident risk.

Material and methods

To conduct the analyses, the data and information from the Polish Central Police Headquarters, the Registration System of Accidents and Collisions (SEWiK), and the Polish Border Guard Headquarters [Pol. *Komenda Główna Straży Granicznej*] were used. Also, aggregate information published by the National Road Safety Council about the valuation of the costs of accidents and collisions on the road network in Poland was analysed (Krajowa Rada Bezpieczeństwa Ruchu Drogowego, 2019). First, the raw data was described, grouped, and tabulated. Then, the analysis focused on the types of road events and circumstances of accidents, with particular emphasis on drowsy driving.

Road traffic accidents in Poland

Road traffic accidents represent a huge public health concern, which needs to be tackled by a multidisciplinary approach. Related deaths and disabilities have social and financial consequences, and are a real public heath challenge (Gopalakrishnan, 2012). The seriousness for public health and safety has been pointed out by numerous surveys.

For years, the number of motor vehicles registered in Poland has been growing systematically. In 2019, almost 31.4 million motor vehicles were registered. According to the data of the Polish Border Guard Headquarters, in 2019, 10.9 million vehicles entered Poland through the external borders of the European Union, including 8.7 million passenger cars (Komenda Główna Policji, Biuro Ruchu Drogowego, 2020).

Since 2014 till 2019, the number of vehicles has increased by 18,6% and the number of all road accidents, including those involving property damage only, has increased by 26,8%.

Fortunately, regarding the past six years, the total number of road accidents resulting in death or injury decreased by 13,3%. Figure 2. presents aggregate evolution in the number of road traffic accidents registered by the police.

Since 2014, a systematic decrease in the number of injured persons in road accidents could be noticed. In the years 2014–2017, a very encouraging decrease in the number of fatalities was also observed. Unfortunately, in 2018 and 2019, the number of fatalities increased.

A fatal victim of an accident is a person who died during or within 30 days from the date of the accident. The death must be a result of injuries sustained during the accident. A seriously injured person is a person who has suffered injuries in the form of blindness, loss of hearing, loss

Table 2. Number of registered motor vehicles in Poland

Year	Motor vehicles	Including		
		cars	lorries	motorcycles
2014	26,472,274	20,003,863	3,037,427	1,189,527
2015	27,409,106	20,723,423	3,098,376	1,272,333
2016	28,601,037	21,675,388	3,179,655	1,355,625
2017	29,634,928	22,503,579	3,248,538	1,427,115
2018	30,800,790	23,429,016	3,338,166	1,502,888
2019	31,388,643	23,874,531	3,387,536	1,553,370

Source: Komenda Główna Policji, Biuro Ruchu Drogowego, 2020, p. 5.

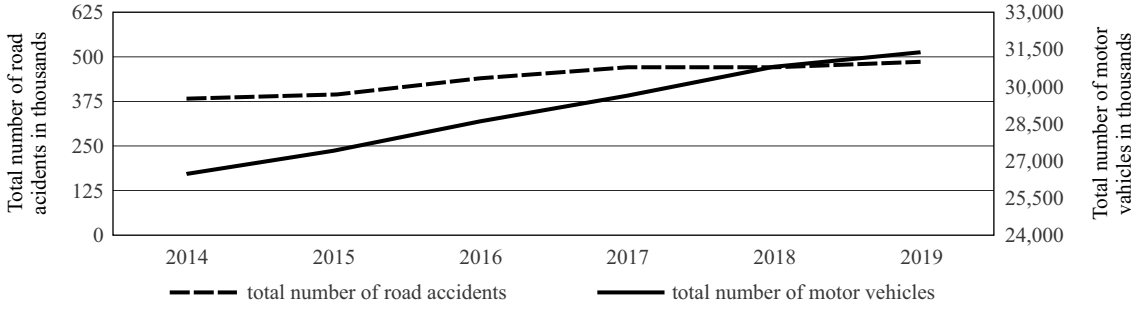

Figure 1. Vehicle fleet and road traffic accidents, 2014–2019

Source: Own calculations based on the SEWiK data available at http://sewik.pl; Komenda Główna Policji, Biuro Ruchu Drogowego, 2020, p. 5.

Figure 2. Road traffic accidents resulting in death or injury, 2014–2019

Source: Own calculations based on the SEWiK data available at http://sewik.pl.

of speech, loss of the ability to procreate, another severe disability, a severe incurable disease or a long-term life-threatening illness, a permanent mental illness, complete substantial permanent inability to work, permanent and significant body disfigurement or deformation, other injuries causing disturbance of the functioning of a bodily organ, or a health disorder lasting longer than 7 days (Komendant Główny Policji, 2015).

It can be stated that in 2019, per 100 roads accidents, there were approximately: 10 fatalities, 35 seriously injured people, and 82 moderately and lightly injured people. In comparison with 2018, the number of fatalities increased by 2%, the number of seriously injured persons decreased by 3%, and the number of moderately and lightly injured persons decreased by 6%.

According to the Registration System of Accidents and Collisions, the vast majority of road accidents is caused by human error. The most common causes of motor vehicle accidents include:

- failure to give the right of way;
- failure to maintain safe distance between vehicles;
- maladjustment of speed to road traffic conditions;
- incorrect overtaking;
- incorrect behaviour towards a pedestrian.

Among the circumstances which lead to road accidents, also pointed out are fatigue and falling asleep. Driving is a complex task involving cognitive, perceptual, motor, and decision-making skills. Sleep disorders can lead to increased inattention, reduced efficiency, and slower reaction (George,

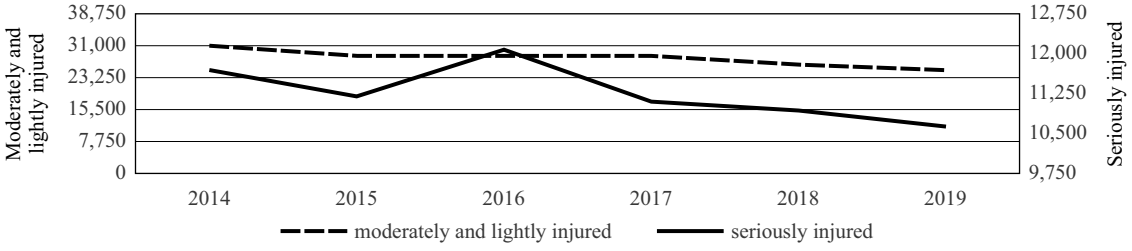

Figure 3. Fatalities and injuries in road accidents, 2014–2019

Source: Own calculations based on the SEWiK data available at http://sewik.pl.

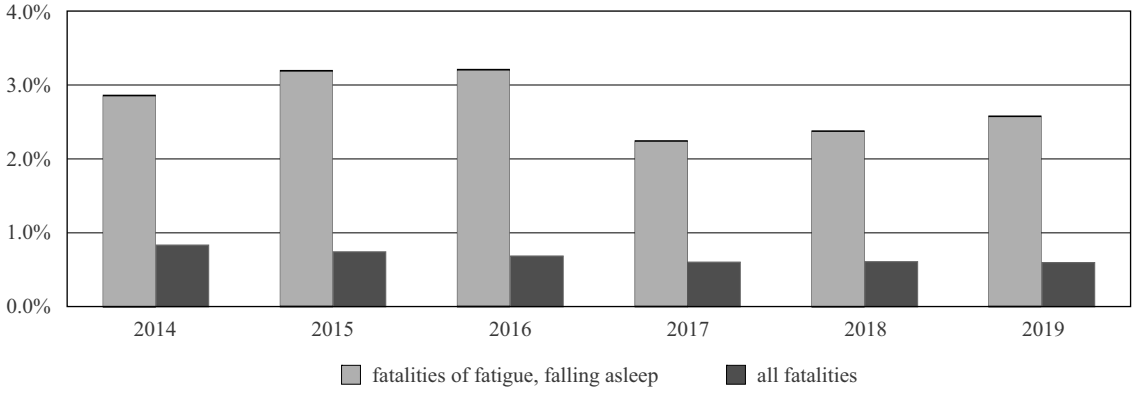

Figure 4. Fatalities and injuries in road accidents, 2014–2019

Source: Own calculations based on the SEWiK data available at http://sewik.pl.

2004). Sleepiness reduces reaction time and has negative influence on vigilance and concentration. The ability to perform attention-based activities is impaired and the quality of decision-making is affected. Sleep-related road-traffic accidents peak between 2:00 a.m. and 6:00 am, and in the mid-afternoon between 3:00 p.m. and 4:00 p.m., which is mainly due to circadian rhythms. An increased awareness of the relationship between sleepiness and motor vehicle crashes will promote health and safety on the roads (Lyznicki et al., 1998).

According to the police statistics, the 'fatigue, falling asleep' cause accounts for almost 1% of all reported road traffic accidents caused by drivers. However, it should be mentioned that the police data is known to understate the number and the seriousness of accidents caused by fatigued drivers (Jamroz & Smolarek, 2012). Road accidents usually do not have a single cause; they are results of several mixed conditions. In the police statistics, only one cause is assigned to each accident – the one which seems to be the main one according to the police officer handling the case.

The share of fatalities caused by fatigued drivers is fourfold greater than in the total traffic road accidents. The share of the injuries in 'fatigue, falling asleep' accidents is three times higher than in the group of all traffic road accidents.

The fatalities in accidents caused by fatigued and falling-asleep drivers constitute approx. 3% of all fatalities, and the injuries constitute approx. 2% of all injured victims of road accidents.

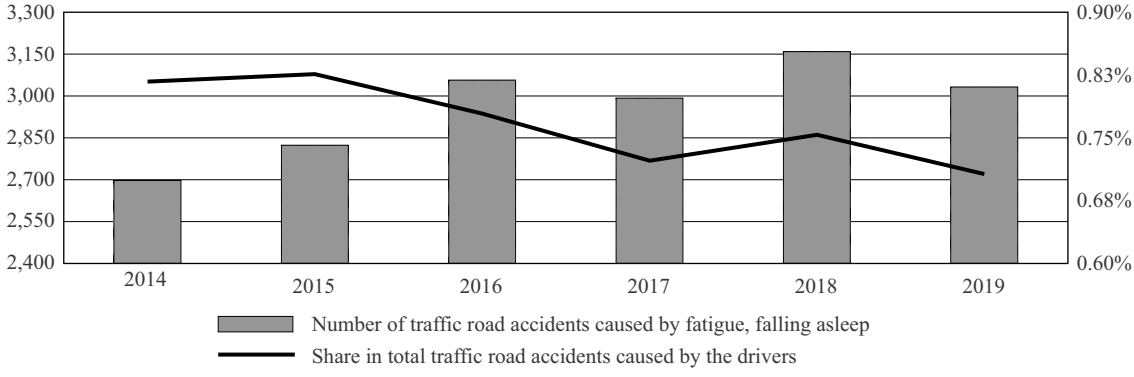

Figure 5. Road accidents – cause 'fatigue, falling asleep', 2014–2019

Source: Own calculations based on the SEWiK data available at http://sewik.pl.

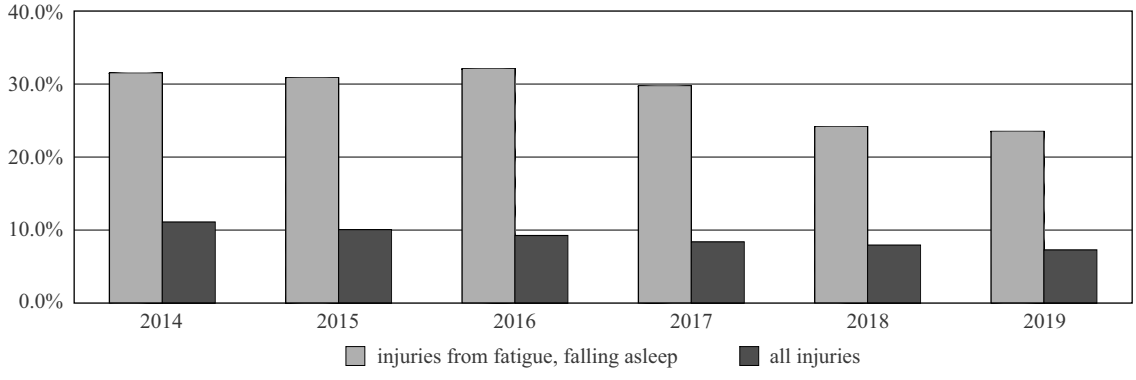

Figure 6. Share of fatalities and injured in the total road accidents caused by the drivers, 2014–2019

Source: Own calculations based on the SEWiK data available at http://sewik.pl.

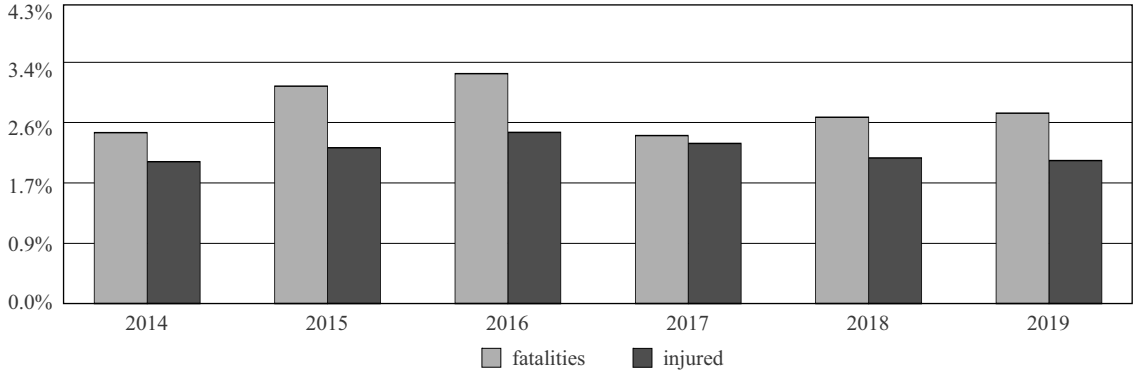

Figure 7. Share of fatalities and injured caused by 'fatigued, falling-asleep' drivers in the total number of fatalities and injured, 2014–2019

Source: Own calculations based on the SEWiK data available at http://sewik.pl.

These indicators have remained at a similar level in the past few years.

The aforementioned data shows that improving process of traffic safety in Poland should focus not only on traffic discipline and infrastructure safety, but also on encouraging road-users to address the causes of sleep deprivation. This may help to reduce the total number of fatalities and serious injuries on the roads in Poland. Proper management of sleep disorders will benefit not only the single road-user, but will also provide widespread benefits to the society as a whole (Morsy et al., 2019). The identification of, and access to, effective treatment may reduce health and societal consequences.

A very important aspect comes in the form of the economic consequences of road traffic accidents in terms of both healthcare resources and lost productivity. The total cost of road accidents is composed of two major parts: direct and indirect costs. Direct costs are classified into:

- healthcare costs related to the period of the patient's inability to work;
- transportation and emergency costs;
- property damage;
- insurance administration and reimbursements;
- police and justice system costs.

Lost GDP and unrealised consumption due to absence from work and premature death constitutes the indirect cost of road traffic accidents (Krajowa Rada Bezpieczeństwa Ruchu Drogowego, 2019, p. 22; García-Altés & Pérez, 2007).

In Poland, road accident losses in 2018 amounted to 2.7% of GDP, including the cost of road accidents resulting in death or injury – 2.1% of GDP. The social costs were estimated at around 56,6 billion PLN (costs of accidents resulting in death or injury amounted to 44,9 billion PLN and accidents involving property damage only to 11,7 billion PLN) (Krajowa Rada Bezpieczeństwa Ruchu Drogowego, 2019, p. 3). It is a very significant cost for the society, and it could be reduced by addressing drowsy driving in a widespread and organised manner.

Concluding remarks and contribution to the discussion

Three major directions of social policy involvment can be observed with respect to the formulation of state social policies: the organisation and operation of the public healthcare system, lifestyle concerns, and the protection of natural environment. Each of these elements should be properly employed in response to any identified risk dangers to public health.

The epidemiology of sleep deprivation has intensified due to dynamic changes taking place in the society. Nowadays, many people sacrifice sleep in favour of other activities during the day. They borrow from sleep time to meet the demands of everyday life (Barnes et al., 2012). It has serious consequences for the quality of life as well as for health and the public safety.

According to the police statistics, the 'fatigue, falling asleep' cause accounts for almost 1% of all reported road traffic accidents caused by drivers. Determining the real impact is difficult, since there is no definitive way to figure out whether an accident is caused by drowsiness or by anything else. Thus, drowsy driving accidents are underreported. Studies show that drowsiness is rarely investigated by police officers as a potential cause of the accident. This results in a paucity of data on this issue (McNicholas & Rodenstein, 2015). To address the drowsy driving, it is crucial to understand the prevalence of the problem and to determine who is at the greatest risk (Higgins et al., 2017). The effect of prevention efforts would be far more satisfactory then.

Sleep-related accidents can have complex causes. It is, therefore, important to address the issue from various approaches, including providing professional help to individuals suffering from sleep disorders. Thus, it is very important to ensure that road-users understand the risk, are able to recognise the symptoms, and are familiar with countermeasures (Report of the Obstructive Sleep Apnoea Working Group, 2013). This will lead to better decisions about driving behaviours.

Raising the public awareness can contribute to preventing potentially hazardous consequences. Road-users should have a chance to change their sleep habits. In most cases, sleep disorders can be reduced to a non-problematic level with proper treatment (Komada et al., 2013). Therefore, it is significant to encourage afflicted persons to seek professional help. Early diagnosis and prompt treatment should be promoted.

Of crucial importance in this issue is establishing clear policies to motivate changes in the behaviour. Such policies can take the form of national laws or administrative regulations. Promoting the development and deployment of drowsy driving warning systems in the vehicles and in the road infrastructure is not without significance.

Effective methods have been developed to change behaviour related to speed choices, drinking alcohol and driving, seatbelt wearing, child restraints use, and the use of hand-held mobile phones while driving. Now it is time to address drowsy driving in a widespread and organised manner. The coordinated effort involving traffic safety and sleep science communities is needed (Higgins et al., 2017). It seems that proper coordination of such actions with formal elements of national healthcare policies is more than advisable and is undeniably in line with public expectations as a source of tangible public health and security improvements and benefits.

It should be emphasised that this issue requires more in-depth analyses, but even the simplest actions can prove to be valuable. In the light of the above, the need for active involvement from national health policymakers in the studied context is of crucial importance for public safety.

References

American Academy of Sleep Medicine (2008). *Sleep Deprivation*. Available at: https://aasm.org/resources/factsheets/sleepdeprivation.pdf (accessed: 07.03.2022).

Avidan, A. Y., & Neubauer, D. N. (2017). Chronic Insomnia Disorder. *Continuum Lifelong Learning in Neurology*, *23*(4), 1064–1092.

Barnes, C. M., Wagner, D. T., & Ghumman, S. (2012). Borrowing from Sleep to Pay Work and Family: Expanding Time-Based Conflict to the Broader Nonwork Domain. *Personnel Psychology*, *65*(4), 789–819.

Biernacki, M. (2017). Modele teoretyczne wyjaśniające zachowanie kierowców na drodze. *Medycyna pracy*, *3*, 401–411.

Chung, F., Yegneswaran, B., Liao, P., Chung, S. A., Vairavanathan, S., Islam, S., Khajehdehi, A., & Shapiro, C. M. (2008). STOP questionnaire: A tool to screen patients for obstructive sleep apnea. *Anesthesiology*, *108*(5), 812–821.

European Commission (2018). *Fatigue*. Directorate General for Transport. Available at: https://road-safety.transport.ec.europa.eu/system/files/2021-07/ersosynthesis2018-fatigue-summary.pdf (accessed: 07.05.2022).

García-Altés, A., & Pérez, C. (2007). The economic cost of road traffic crashes in an urban setting. *Injury Prevention*, *13*, 65–68.

George, C. F. (2004). Sleep. 5: Driving and automobile crashes in patients with obstructive sleep apnoea/hypopnoea syndrome. *Thorax*, *59*(9), 804–807.

Gopalakrishnan, S. (2012). A public health perspective of road traffic accidents. *Journal of Family Medicine and Primary Care*, *1*(2), 144–150.

Higgins, J. S., Michael, J., Austin, R., Åkerstedt, T., van Dongen, H. P. A., Watson, N., Czeisler, C., Pack, A. I., & Rosekind, M. R. (2017). Asleep at the wheel: The road to addressing drowsy driving. *Sleep*, *40*(2). https://doi.org/10.1093/sleep/zsx001

Hirshkowitz, M., Whiton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., Hazen, N., Herman, J., Katz, E. S., Kheirandish-Gozal, L., Neubauer, D. N., O'Donnell, A. E., Ohayon, M., Peever, J., Rawding, R., Sachdeva, R. C., Setters, B., Vitiello, M. V., Ware, J. C., & Adams Hillard, P. J. (2015). National Sleep Foundation's sleep time duration recommendations: Methodology and results summary. *Sleep Health*, *1*(1), 40–43.

Jamroż, J., & Smolarek, L. (2012). Analiza wpływu zmęczenia kierowców na ryzyko wypadków na drogach krajowych. *Drogownictwo*, *4*, 121–126.

Johns, M. (1997). https://epworthsleepinessscale.com/about-the-ess/.

Kiciński, P., Zakrzewski, M., Dybała, A., Zubilewicz, R., Mosiewicz, J., & Jaroszyński, A. (2012). Obturacyjny

bezdech senny – zasady diagnostyki i leczenia. *Forum Medycyny Rodzinnej*, *6*(5), 228–235.

Komada, Y., Asaoka, S., Abe, T., & Inoue, Y. (2013). Short sleep duration, sleep disorders, and traffic accidents. *IATSS Research*, *37*, 1–7.

Komenda Główna Policji, Biuro Ruchu Drogowego (2020). *Wypadki drogowe w Polsce w 2019 roku*.

Komendant Główny Policji (2015). *Zarządzenie Nr 31 Komendanta Głównego Policji z dnia 22 października 2015 r. w sprawie metod i form prowadzenia przez Policję statystyki zdarzeń drogowych.*

Krajowa Rada Bezpieczeństwa Ruchu Drogowego (2019). *Wycena kosztów wypadków i kolizji drogowych na sieci dróg w Polsce na koniec roku 2018, z wyodrębnieniem średnich kosztów społeczno-ekonomicznych wypadków na transeuropejskiej sieci transportowej*.

Lyznicki, J. M., Doege, T. C., Davis, R. M., & Williams, M. A. (1998). Sleepiness, driving, and motor vehicle crashes. *Journal of the American Medical Association*, *279*(23), 1908–1913.

Maycock, G. (1996). Sleepiness and driving: The experience of UK car drivers. *Journal of Sleep Research*, *5*, 229–237.

McNicholas W.T., & Rodenstein D. (2015). Sleep apnoea and driving risk: The need for regulation. *European Respiratory Review*, *24*, 602–606.

Morsy, N. E., Farrag, N. S., Zaki, N. F. W., Badawy, A. Y., Abdelhafez, S. A., El-Gilany, A. H., El Shafey, M. M., Pandi-Perumal, S. R., Spence, D. W., & Bahammam, A. S. (2019). Obstructive sleep apnea: Personal, societal, public health, and legal implications. *Reviews on Environmental Health*, *34*, 153–169.

Powell, N. B., Schechtman, K. B., Riley, R. W., Guilleminault, C., Chiang, R. P. Y., & Weaver, E. M. (2007). Sleepy driver near-misses may predict accident risks. *Sleep*, *30*(3), 331–342.

Report of the Obstructive Sleep Apnoea Working Group (2013). *New Standards and Guidelines for Drivers with Obstructive Sleep Apnoea syndrome*.

Sateia, M. J. (2014), International classification of sleep disorders-third edition: Highlights and modifications. *Chest*, *146*(5), 1387–1394.

Sateia, M. J., & Nowell, P. D. (2004). Insomnia. *Lancet*, *364*(9449), 1959–1973.

Sateia, M. J., Buysse, D. J., Krystal, A. D., Neubauer, D. N., & Heald, J. L. (2017). Clinical Practice Guideline for the Pharmacologic Treatment of Chronic Insomnia in Adults: An American Academy of Sleep Medicine Clinical Practice Guideline. *Journal of Clinical Sleep Medicine*, *13*(2), 307–349.

Semelka, M., Wilson, J., & Floyd, R. (2016). Diagnosis and Treatment of Obstructive Sleep Apnea in Adults. *American Family Physician*, *94*(5), 355–360.

Spicuzza, L., Caruso, D., & Di Maria, G. (2015). Obstructive sleep apnoea syndrome and its management. *Therapeutic Advances in Chronic Disease*, *6*(5), 273–285.

Szelenberg, W. (2003). Standardy leczenia bezsenności Polskiego Towarzystwa Badań nad Snem. *Farmakoterapia w Psychiatrii i Neurologii*, *1*, 5–16.

Taźbirek, M., Pierzchała, W., Ograbek-Król, M., Skoczyński, S., & Barczyk, A. (2016). *Zaburzenia oddychania podczas snu*. Śląski Uniwersytet Medyczny w Katowicach.

Tefft, B. C. (2012). Prevalence of motor vehicle crashes involving drowsy drivers, United States, 1999–2008. *Accident Analysis & Prevention*, *45*, 180–186.

Watson, N. F., Badr, M. S., Belenky, G., Bliwise, D. L., Buxton, O. M., Buysse, D., Dinges, D. F., Gangwisch, J., Grandner, M. A., Kushida, C., Malhotra, R. K., Martin, J. L., Patel, S. R., Quan, S. F., & Tasali, E. (2015). Recommended Amount of Sleep for a Healthy Adult: A Joint Consensus Statement of the American Academy of Sleep Medicine and Sleep Research Society. *Sleep*, *38*(6), 843–844.

Wichniak, A., & Poradowska, E. (2017). Zdrowy sen. *Medycyna praktyczna – psychiatria*, *3*, 20–26.

Wichniak, A., Jankowski, K. S., Skalski, M., Skwarło-Sońta, K., Zawilska, J. B., Żarowski, M., Poradowska, E., & Jernajczyk, W. (2017a). Treatment guidelines for Circadian Rhythm Sleep-Wake Disorders of the Polish Sleep Research Society and the Section of Biological Psychiatry of the Polish Psychiatric Association. Part I. Physiology, assessment and therapeutic methods. *Psychiatria polska*, *51*(5), 793–814.

Wichniak, A., Jankowski, K. S., Skalski, M., Skwarło-Sońta, K., Zawilska, J. B., Żarowski, M., Poradowska, E., & Jernajczyk, W. (2017b). Treatment guidelines for Circadian Rhythm Sleep-Wake Disorders of the Polish Sleep Research Society and the Section of Biological Psychiatry of the Polish Psychiatric Association. Part II. Diagnosis and treatment. *Psychiatria polska*, *51*(5), 815–832.

Pływaczewski, R., Brzecka, A., Bielicki, P., Czajkowska-Malinowska, M., Cofta, S., Jonczak, L., Radliński, J., Taźbirek, M., & Wasilewska, J. (2013). Zalecenia

Polskiego Towarzystwa Chorób Płuc dotyczące rozpoznawania i leczenia zaburzeń oddychania w czasie snu (ZOCS) u dorosłych. *Pneumonologia i Alergologia Polska*, *81*(3), 221–258.