REVIEW ARTICLE

Pol J Aviat Med Bioeng Psychol 2017; 23(1): 22-28
DOI: 10.13174/pjambp.19.06.2018.03

THE POTENTIAL INFLUENCE OF OBESITY ON THE ABILITY TO DRIVE

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Source of support: Source of support: Military Institute of Aviation Medicine for support under the grant for Young Scientists no. 510-22-00 (to Michał Janewicz) and National Science Centre under the grant 2013/09/B/NZ7/03763.

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Introduction: Obesity is now an epidemic. The incidence of obesity is estimated at 10% among men and 14% among women. Each year 28 million deaths are reported as a consequence of excess weight and obesity. A study demonstrating a higher risk of death of obese people due to car accidents was the starting point for this review.

Methods: A systematic review has been made on the influence of obesity and its comorbidities on psychomotor and cognitive skills. The Web of Science and PubMed search engines were used.

Results: Existing studies have shown that obese drivers are more prone to injury due to motor vehicle crashes. Obesity has influence on psychomotor skills starting from childhood to the old age. Some studies conclude that being overweight or obese is associated with lower cognitive abilities. No studies focused on the influence of obesity on driving abilities and skills were found.

Conclusions: Information about difficulties of morbidly obese drivers while driving a car are indispensable. So far no such studies were conducted.

Keywords: obesity, driver, psychomotor abilities, BMI, cognitive function

Figure: 1 • **References:** 40 • **Full-text PDF:** http://www.pjambp.com • **Copyright** © 2017 Polish Aviation Medicine Society, ul. Krasińskiego 54/56, 01-755 Warsaw, license WIML • **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education

INTRODUCTION

Over the last few decades the prevalence of obesity has increased [28]. According to the newest available World Health Organization estimations, in 2014 approximately 600 million people were obese, while only a year later, this number rose to 700 million [2]. Commercial driver medical examination from 88,246 commercial drivers between 2005 and 2012 has shown that most drivers were obese (53.3%, BMI >30.0 kg/m2) and morbidly obese (26.6%, BMI >35.0 kg/m2) [36]. In the coming years, this trend will most probably continue. It has been suggested that in terms of preventable causes of death, obesity is currently outrun only by smoking when considering biggest preventable causes of death [10]. Obesity could now be considered as an epidemic. As a major health risk, obesity is receiving increased attention from healthcare professionals and researchers. The incidence of obesity is estimated at 10% among men and 14% among women. Each year 28 million deaths are reported as a consequence of individuals' excess weight [2].

Obesity, and morbid obesity in particular, may make life more difficult in many ways. Everyday tasks become difficult or even impossible to deal with. Decreased physical dexterity is accompanied by deficits in psychological domains. Jehle et al. demonstrated that obese people face a higher risk of death due to car accidents [19]. It has also been established that ability and personal determinants of fitness to drive are relevant to driving behavior [34].

Morbidly obese people often suffer from comorbid diseases such as: type 2 diabetes, hypertension, heart diseases, strokes, dyslipidemia, insulin resistance, etc. [2]. Moreover, evidence suggests that people suffering from obesity are often more prone to experience distress, depression and eating disorders, such as the Binge Eating Disorder, among others [17,33]. Some of these complications and comorbidities of obesity may cause drowsiness during the day [39]. Existing research points out that attention lapses are positively correlated with cognitive failure [32] which may be related to fatigue. All of the above mentioned complications of obesity could have impact on psychomotor abilities and driving skills. The goal of this study is to review an up-to-date evidence-base of published studies in relation to the influence of obesity on psychomotor and cognitive skills of drivers. The aim of the review was to asses if there is any scientific evidence of the differences between representative drivers group and morbidly obese drivers.

METHODS

Literature on the influence of obesity and its complications and comorbidities on psychomotor and cognitive skills has been reviewed. The Web of Science and the PubMed search engines were used. The final search was conducted on 3rd November 2016. The keywords used were: obesity, driver, automobile, car, road, accidents - to achieve the broadest possible search results. For a paper to be included in the review it had to be an original study or a review article. Information about obesity in drivers must have been focused on the topic. Only full texts written in English were considered. We excluded conference abstracts and studies not focused on the topic. The process of selecting studies consisted of screening and excluding papers not related to the topic and an eligibility check. The first screening focused on articles' titles and whether they are within the scope of this research. The second screening focused on abstracts. The remaining articles were carefully read and selected for obtaining the best fitting data related to obesity and cognition or driving and cognition or obesity and driving. Review was made according to the Prisma Statement [26]. Papers used in the review are marked with (*) in the reference section.

RESULTS

From the search outcomes, 14 papers have been selected as relevant (Fig. 1). Selected articles were focused on the topic of interest and thus carefully reviewed. Additionally, this review contains 16 articles known to the authors from previous studies which were also focused on this topic but were not found during the database search for this paper.

Studies have shown that obese drivers are more prone to injury due to motor vehicle crashes. Obesity influences the body structure. Jehle et al. in their study on using seatbelts while driving concluded that odds of seatbelt use for obese drivers are significantly lower than for healthy weight drivers [18]. It is possibly due to changes in the body structure which make it difficult to strap one's seatbelt. Kent, Forman and Bostrom's study using obese cadavers showed that obese subjects experienced greater forward displacement when crashing into a wall compared to healthy ones. Authors explained their findings by pointing out that, because of the excess of fatty tissue, obese drivers' bodies travelled a longer distance before their motion was stopped by the seatbelt. Moreover, because of their greater mass, obese drivers'

bodies need stronger seatbelt system to restrain them. This may serve as an explanation for the increased risk of thoracic injuries in obese car crash casualties [21]. The Forman et al. study seeks to compare the kinematics, dynamics, and injuries in post mortem human surrogates of people with obesity to average weight post mortem human surrogates in frontal impact car crash tests. Subjects with obesity exhibited significantly greater forward motion of the head, the pelvis, peak belt forces, forward excursions of the head and knees compared to the average weight. Subjects with obesity also exhibited backwards torso rotation at the time of maximum forward excursion, whereas the average-sized did not [11].

The above-mentioned factors and possibly other factors, as mentioned in the introduction, may be responsible for the increased risk of death and injury in obese drivers. The influence of obesity on mortality and injuries of drivers in motor vehicle crashes seems to have been thoroughly examined. The review of the available papers revealed rather similar outcomes. There is an increased risk of death among moderately obese (Odds ratio – 1.212) and morbidly obese (OR – 1.599) drivers [19]. The Zhu et al. study revealed that the risk of death due to a car crash is increased significantly among obese men. The, study did not show significant associations between BMI and change in velocity concerning fatality among women [40]. A recent study by Rice et al. assessed risk ratios (RR) of fatal injury during car collisions involving obese drivers. The estimated RR were increasing as BMI did. RR also varied by gender. Women had higher risk

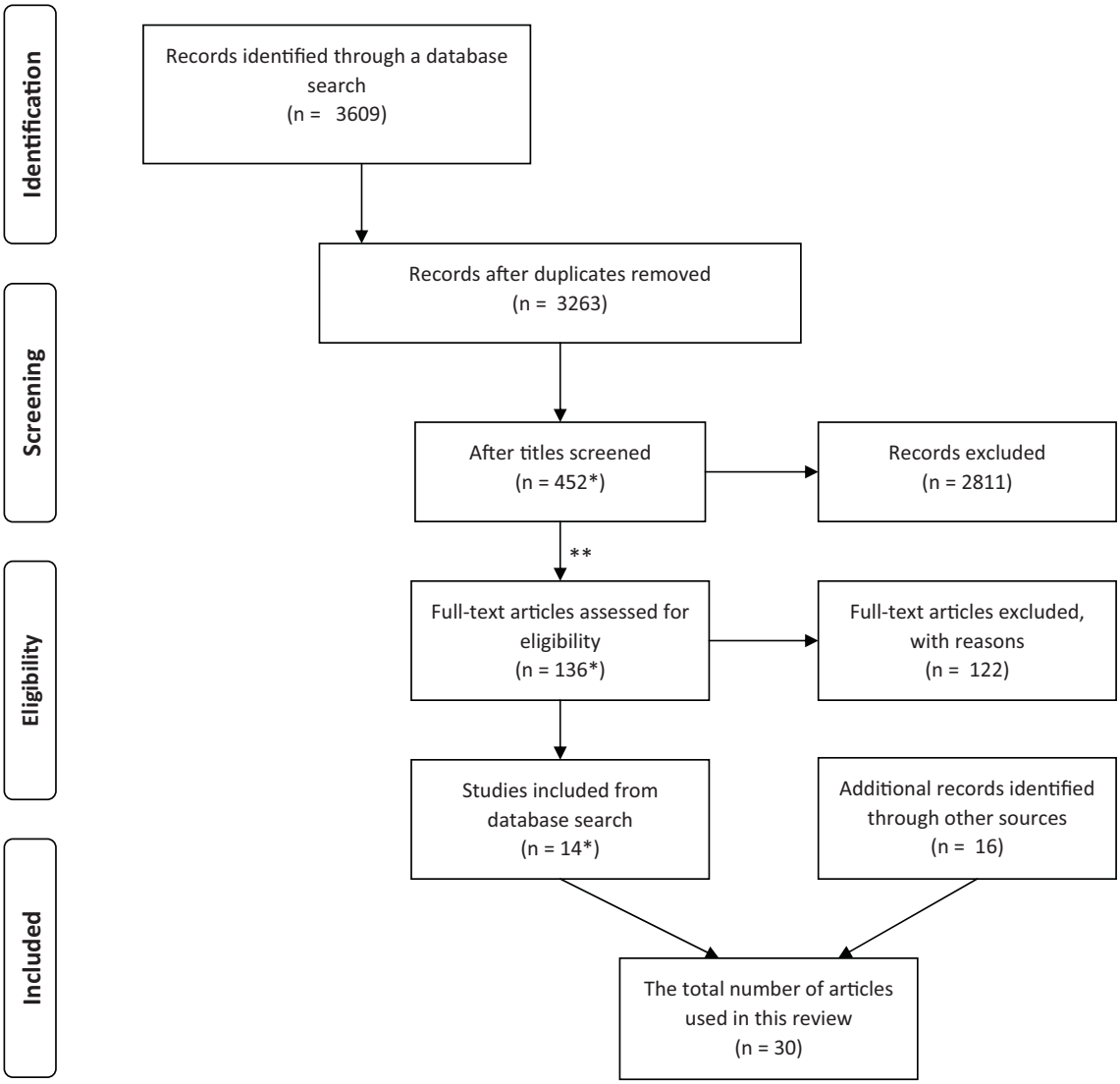

Fig. 1. The Prisma flow diagram.

* Among these, 8 articles were already known to the authors from previously made studies (as this is not the first time the authors focus on the topic of obesity), 6 articles - new to the authors and used in the review are marked additionally with (^) in the reference section.

** Records excluded after screening focused on abstracts: n=316.

ratios for all three types of obesity I – 1.36 vs. 1.11, II – 2.20 vs. 1.25 and III – 1.92 vs. 1.75 compared to men. Drivers with obesity class II and III, were 48% to 78% respectively more likely to die in a car crash than healthy weight drivers [31]. The Pal et al. study showed that the BMI of accident victims has significant influence on the occurrence of lower extremity injuries and abdomen injuries [29]. A study of obesity in non-fatal car crashes revealed that obese male drivers had significantly higher risk of being injured than male normal weight drivers. Also, non-fatal injury risks were not increased in obese women compared with standard weight females [25]. A study of motorcycle riders revealed that, comparing to normal-weight adult motorcycle riders, obese riders had different injury characteristics, different bodily injury patterns and spend a longer time in hospitals [24]. A study of traffic crash risks in drivers with morbid obesity before and after weight loss surgery by Bhatti et al. suggests that morbidly obese drivers are three times more likely than the population norm to be involved in a serious motor vehicle crash. The analysis and crash counts indicate that weight loss surgery does not substantially decrease these risks in the short-term. The results remained unchanged even after considering a longer follow-up of 5 years after surgery [3].

All of the above mentioned studies focused on the impact of obesity on the effects of car accidents from the mechanical point of view. However, obesity can also influence individuals' behavior due to the related complications and comorbidities which can in turn impact cognitive and psychomotor skills.

Obesity can influence psychomotor skills ever since childhood years. A recent study on the effect of age, sex and BMI on fundamental motor skills among 4-6 year olds showed significant effects of BMI on jumping, skipping, hooping, ladder climbing, stair climbing, kicking and striking [37]. Another study on obese children, apart from claiming that being obese affects gross motor skills, pointed out the decrease of fine motor skills such as: precision and manual dexterity in obese patients in comparison with healthy weight children [12].

A group of studies that focused on the speed of cognitive aging among the overweight and obese provided an interesting source of information about the long-term effects of high BMI. In numerous studies Dahl, Hassig et al. assessed the association between BMI and cognitive function in twin population. Their conclusions were that being overweight or obese in midlife and late midlife was associated with lower cognitive abilities in later life [5,16]. There have been no studies identified that would focus on the influence of obesity on driving abilities and skills. Among all comorbidities related to obesity, presence of obstructive sleep apnea might be one of the underlying mechanisms explaining the impact of obesity on driving abilities. It has been found that sleep apnea impairs cognitive and psychomotor functioning. A study of 49 patients with sleep apnea showed that one in four had some kind of neurocognitive dysfunction [1,23]. Hannon et al. concluded that poor sleep quality and sleep fragmentation, common for sleep apnea, were associated with poorer psychomotor functioning, memory and poorer scores in mathematical part of the academic test [15]. Although these impairments may be improved by treatment, they are still an existing problem [4]. In relation to driving, subjects with obstructive sleep apnea are under a greater risk of motor vehicle accidents. Data from Karimi et al.'s study suggests that long distance drivers are more prone to obstructive sleep apnea and their group may be overrepresented in sleep apnea population in comparison to general population [20]. Sleepiness is one of the important symptoms of sleep apnea. As human error is the leading cause of car crashes, being vigilant is crucial. Lack of attention or cognitive impairment increases the risk of accident. While drowsy driving, individuals increase the risk. Drivers with obstructive sleep apnea, if not treated, may be drowsy more often and their sleepiness may not be controlled as well because 'sleeping it off' may not be as effective [13].

As demonstrated so far, our knowledge of the influence of obesity and its' comorbidities on driving abilities and skills is limited. However, it appears clear that all of the above mentioned factors could have impact on cognition. Which aspects of cognition, important for driving abilities and skills, could potentially be impaired by obesity? Four main cognitive areas have been identified: perception, attention, memory and cognitive control. A study of audiovisual reaction time revealed a statistically significant longer reaction times for both auditory and visual stimuli in obese participants, compared to normal weight patients' reaction times [6]. Obese subjects in comparison with healthy ones made significantly more errors on The Wisconsin Card Sorting Test (WCST), which is a measure of planning, shifting among stimuli and cognitive flexibility. Obese patients made more perseverance and non-perseverance errors. They have given answers that were less consistent with

the logical concept of the task. Obese participants also needed more cards to start with and they made less categories than others. Also one of the cited studies assessed the level of depression in obese participants which was higher than in the control group and a positive correlation between BMI, depression and poorer WCST scores was observed [8,38]. The Gambling Task (GT) is a computerized test evaluating one's ability to make decisions and valuing risk, reward and punishment. Studies using GT demonstrate similar outcomes. Obese groups were making significantly more poor decisions than the control condition. Moreover, in comparison to healthy subjects, obese participants did not learn the pattern which would let them to maximize their score. Decision making is not generally assessed in obesity, but it seemed to be significantly deficient in obese test group. Although authors were unsure whether other comorbidities of eating disorders were not responsible for such deficits, they stated that the obese patients group was representative, so these comorbidities would also be significant in the whole population [30,38]. Gunstad et al. trials showed that BMI is related to cognitive test scores and that people with elevated weight have reduced executive function performance. The strongest relationships were found for switching of attention (r= 0.2) and verbal interference (r= -0.23) with healthy weight subjects outperforming patients suffering obesity [14]. Compared to non-obese subjects obese individuals showed lower, performance in a trial of switching skills, inhibition, flexibility and attention [9,38]. Moreover, an MRI study on the relation between BMI and gray matter volume showed a negative correlation between BMI and the gray matter volume among men. This is a suggestion that from the anatomical point of view, obese men may be in higher risk of declines in cognition and other functions [35]. Also, The Framingham Heart Study showed differences in cognitive performance among men [7]. Such sex difference dissimilarity data is important for future testing, especially when relating these to the ones showing that obese women had higher risk ratios for death in car crash than men. The abovementioned appears to be conflicting with each other [31,40]. There are studies which concluded that having diseases caused by obesity may be related to declines in episodic memory [28]. Also, a study exists in which relation in working and verbal memory and mental flexibility is significant due to the age factor [22].

CONCLUSIONS

Accordingly to the aim of this review, as described above, there are some differences between drivers suffering from obesity and regular-weight drivers. The need for studies on the difficulties experienced by morbidly obese drivers have been identified. So far, no such studies precisely concerning, obese drivers have been conducted, i.e. there has been no research identifying the impact of obesity specifically on driving skills. Due to obesity being identified as an epidemic in the current times, it seems rather surprising that such research has not been conducted yet, especially taken how common a behavior driving now is. At the same time, it appears that obesity may affect driving skills. That is why we advocate for additional studies that will help to develop the knowledge on this topic, especially in the face of the constantly rising number of obese patients in the world. The conducted studies would be essential in the future, such research is extremely important. Thanks to the research involving morbidly obese people, car and in-car device manufacturers and designers may have an opportunity to adapt their products to the needs of obese drivers, resulting in increased security of our lives.

AUTHORS' DECLARATION:

Study Design: Michał Janewicz, Anna Trejnowska, Stefan Gaździński, Mariusz Wyleżoł; **Data Collection:** Michał Janewicz, Anna Trejnowska, Stefan Gaździński, Mariusz Wyleżoł; **Manuscript Preparation:** Michał Janewicz, Anna Trejnowska, Stefan Gaździński, Mariusz Wyleżoł; **Funds Collection:** Michał Janewicz, Anna Trejnowska, Stefan Gaździński, Mariusz Wyleżoł; The Authors declare that there is no conflict of interest.

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ACKNOWLEDGEMENTS

The views, opinions, and findings contained in this article are our own and should not be construed as an official Polish Air Force position, policy, or decision, unless so designated by other official documentation.

Cite this article as: Janewicz M, Trejnowska A, Gaździński S, Wyleżoł M. The Potential Influence Of Obesity On The Ability To Drive. Pol J Aviat Med Bioeng Psychol 2017; 23(1): 22-28. DOI: 10.13174/pjambp.19.06.2018.03