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Medical Fitness to Drive: Steering the conversation towards Obesity?

In 1869, the scientist Mary Ward was killed in what would become the first road fatality in Ireland, and indeed the world[1]. Since then, road safety has never been far from the Irish collective consciousness as we strived for improvements. Now, almost 150 years later, Ireland is being recognised for progress in road safety[2]. Road deaths per million inhabitants has decreased from 107 in 2001 to 36 in 2015. From 2014-2015, there was a 14% reduction in deaths on Irish roads in contrast to the 1% increase noted across European Roads. This sets us apart and positions Ireland in second place out of the 28 European Union Member States for progress in Road Safety[2].

Our leading position here is not accidental but rather a testament to the close cooperation of the Road Safety Authority with bodies such as An Gardai Suiochana and most recently the Royal College of Practitioners of Ireland. The establishment of the National Office for Traffic Medicine with the annual publication of the Sláinte agus Tiomáint: Medical Fitness to Drive Guidelines embodies the continued pursuit for progress.

These guidelines highlight how our health has the potential to influence our ability to drive safely[3]. In order for these guidelines to remain clinically effective and relevant they must reflect the health of the Irish population, addressing common medical conditions faced by current road users and anticipating future changes and challenges in health and road safety.

Globally, we have witnessed a precipitous rise in obesity. Focusing on our own population, two out of five Irish adults are overweight and one in four are obese[4]. According to the WHO, Ireland is set to become the most obese country in Europe by 2030[5]. This worrying trend places a heavy burden on the health system and will no doubt leave a damaging legacy, the scale of which is only beginning to surface.

As obesity increases in Ireland, it is clear that our road users are concurrently becoming more obese. However, while complications of obesity such as obstructive sleep apnea are addressed in the latest Medical Fitness to Drive Guidelines, obesity itself is not[3]. Obesity, by definition of increased body mass index (BMI), is virtually absent. This is remarkable, as while the steady climb towards an obesogenic society has resulted in numerous public health promotion measures, the link between obesity and fitness to drive has yet to be considered[6,7]. This raises the question as to whether obesity affects driving ability and whether this impinges on road safety. Could the Irish journey to obesity hinder the

exceptional progress we have seen in road safety? Is it time to steer the conversation surrounding fitness to drive towards obesity?

Obesity and Driving

Driving is a complicated dynamic task requiring the interaction of the individual, the vehicle and the environment. The visual and auditory senses obtain the information which is processed using a combination of cognitive and behavioural dexterity to ultimately settle on a decision which the musculoskeletal system then achieves[3]. By limiting the function of these intrinsic faculties, obesity may threaten the safe execution of this task.

Firstly, increased body mass imposes abnormal mechanics on body movement[8,9]. This can limit the range of motion and decrease the tolerance of fixed positions[10,11]. When it comes to driving, neck mobility, which is essential for scanning the full extent of the road, examining blind spots and changing lanes, is of particular importance. Although limited to elderly drivers, the Maryland Pilot Study found that head and neck rotation had a role in predicting driving impairment[12]. Relating this to obesity, a study of commercial drivers conducted in Turkey found that obese drivers failed a test of their peripheral vision significantly more than non-obese counterparts[13].

Secondly, changes in body mass composition influences muscle strength[10]. Evidence reports that obese subjects are significantly weaker and slower than non-obese subjects[14]. In terms of driving, to remain in control of steering and breaking, strength, mobility and adequate reaction times are required. For instance, even the slightest delay in shifting the leg from the accelerator to the brake can be critical with potentially devastating outcomes. Studies have revealed a correlation between lower limb function and the capacity to carry out activities of daily living safely[15]. While driving was not included in the activities of daily living, the Maryland Pilot Study, found that a Rapid Pace Walk test was a predictor of driving impairment in the elderly[12]. This test measures the time taken to walk 20 feet. While this was not examined in obese individuals, given that they have been shown to walk at a slower velocity with an altered gait cycle it would stand to reason that they would do poorly on this test[16].

Thus the reduction in strength, mobility and speed of obese drivers soley due to increased body mass may impair their ability to execute decisions safely and effectively. However, it appears that this

aspect of obesity has been overlooked while the conversation centres instead on the complications of obesity.

Complications of Obesity

Obesity is associated with a myriad of chronic conditions such as diabetes, obstructive sleep apnoea, hypertension, cardiovascular disease and musculoskeletal problems[17]. The impact of these on driving safety is well represented in the literature and indeed the Irish guidelines address these individually. However, not all obese individuals have these complications. Health professionals are aware that obesity may exist in the absence of complications or more commonly, in advance of complications. At present, the guidelines do not feature this cohort. However, evidence is emerging which suggests that the absence of complications does not equate to an absence of risk when it comes to driving.

Studies reporting that obese individuals are at an increased risk of driving impairments largely centre on two issues; body mass and unrecognised complications. Through the example of excessive day-time sleepiness and OSA, this can be appreciated.

Excessive sleepiness behind the wheel as a causative factor in collisions has been well represented in the literature[18-21]. Typically, excessive sleepiness is attributed to OSA which is highly related to obesity[20]. In a Turkish study, a significant difference in reaction time between those with OSA and those without was demonstrated[13]. The association with untreated OSA and collisions is well elucidated with conventional treatment proven to decrease collision rates[22,23]. However, of interest to us, studies have demonstrated that increased body mass in the absence of OSA is a cause of excessive sleepiness[24]. Furthermore, a recent study conducted in Brazil found that an increased abdominal circumference was independently associated with sleepiness[25].

While it is well known that increased BMI is a risk factor for OSA, The Journal of Traffic Injury Prevention have recently shown that subjective reports of excessive day time sleepiness are unreliable[26]. They found no correlation between a patient's reports and objective findings of sleepiness. Obese patients may not present with excessive sleepiness thus the ability to extract a thorough history is essential in assessing fitness to drive. Xie et al. document that BMI greater than 30, hypertension and diabetes are associated with OSA in commercial drivers[27]. Furthermore, excessive daytime sleepiness was significantly higher in those with a history of a previous road traffic accidents[27]. This is important because although the role of the medical history in assessing fitness to

drive is well established it reinforces the concept of unrecognised complications in those with an increased BMI. Thus, the increased body mass and the undiagnosed complications of obesity constitute an increased threat to driver safety. Hence, it needs to be considered whether including this patient cohort in the guidelines would encourage a thorough history and facilitate an easier assessment of the obese patient's fitness to drive.

Obesity and Collisions

Although collisions are complex it is essential to have a basic understanding of the physics in order to appreciate the role obesity has to play.

Newton's first law of motion states that objects will maintain their course unless acted upon by an unbalanced force. This resistance to change or inertia forms the basis of safety mechanisms. For instance, the seatbelt provides an unbalanced force to bring you to rest rather than allowing you to continue your course of motion. Without this stopping force of the seatbelt, in a collision you would continue through the windshield as a projectile. Similarly, the headrest provides the unbalanced force necessary to minimise a whiplash injury in a rear-ended collision by bringing your head from rest into motion.

Newton's second law states that the force that acts on a body is directly proportional to the product of the mass and rate of acceleration while Newton's third law states that for every action there is an equal and opposite reaction. Together, these laws describe how in a collision the unbalanced force that stops your motion will exert a force that is the product of your mass and acceleration. This explains the fatality associated with speeding but also the reasoning behind airbags. Airbags absorb a proportion of this force, thus reducing the force exerted on the driver.

Increased body mass thus increases the energy dissipated in a collision, hence, we can appreciate how obesity has the potential to increase the risk of injury[28]. Increased energy implies that an obese individual would be propelled further with an increased force and the safety mechanisms such as the seatbelt would require more work to arrest an obese individual's forward motion[29].

While the laws of physics are not up for debate, currently there is no consensus on the relationship between road traffic injuries and obesity. Some researchers argue that obesity is protective, claiming the cushioning effect of the adipose tissue acts similarly to an airbag, absorbing some of the energy

generated during the collision[30]. The opposing argument however, is well-represented with studies consistently demonstrating an association between obesity and collision fatality. Viano et al and Mock et al availed of the National Automotive Sampling System data to demonstrate an increased fatality risk in obese occupants[31,32]. Mock et al. further established that the odds ratio for death in a collision increased by 1.013 for each kilogram increase in weight[32]. Similarly, a matched pair cohort published in the British Medical Journal stated that obese individuals were more likely to die than non-obese individuals in the same collision[33].

To address these conflicting schools of thought, a systematic review published in the Asia-Pacific Journal of Public Health in 2011 evaluated whether mortality was increased for obese drivers[35]. They included nine studies in their meta-analysis. These studies were selected based on clear inclusion and exclusion criteria with independent quality assessment and data extraction carried out by two independent reviewers. These reviewers had a kappa agreement of over 87%. The funnel plot was asymmetrical suggesting studies were overlooked due to publication bias. With that said, they did find that obesity was associated with a significantly higher fatality risk, reporting an odds ratio of 1.89. The pattern of injury was also different with obese individuals experiencing increased lower extremity fractures. Interestingly, three of the included studies found that obese individuals had less head injuries.

These results may not give an accurate representation as obesity is known to be associated with increased complications and poorer trauma outcomes. Chobhan and Neville demonstrated that even with similar injuries, obese patients do worse[36,37]. They are more likely to require high level care in an ICU and a longer length of stay[38]. A Scandinavian study further strengthens this by showing how an increase in length of stay of 0.82 days with every 10 unit increase in BMI[39]. While it is hypothesised that the higher incidence of co-morbidities accounts for this, further studies are required to elucidate the extent of their impact[40,41.] Similarly, co-morbidities may be a confounding factor in the increased mortality reported in the aforementioned systematic review, however regardless of this the evidence to date suggests that mortality is increased.

Despite this evidence and the prevalence of obesity in our society, there is a paucity of biomechanical studies examining obesity and road safety[29]. Research is only beginning to examine the impact body mass has on the performance of protection systems such as seat belts and airbags.

<u>Obesity and Safety Systems</u>

It is well established that seat belts are effective. By decreasing fatalities by 45% and injury by 50%, increasing seatbelt usage has been proven to be the most economical means of decreasing death and injury in collisions[42]. A increase in usage of one percent prevents 800 million injuries and saves 270 lives. Given that obese individuals are at a higher risk of injury and mortality, ensuring that seat belts function effectively in this group is requisite for road safety.

The Road Safety Authority states "the most important factor in determining the correct restraint is weight"[43]. However, seat-belts have typically been designed for and assessed on those with a normal BMI.

Seat-belts are designed to engage with sturdy anatomical structures with the lap belt engaging the anterior superior iliac spine (ASIS) of the pelvis and the shoulder belt engaging the clavicle and rib cage. Studies show that increased BMI alters the routing of the seatbelt, positioning it further from these bony structures and introducing slack. Reed et al. found that an increase in BMI of 10kg/m2 correlated with the lap belt 43mm further from and 21mm superior to the ASIS[44]. This increased amount of soft tissue restricts the engagement of the bony structures thus limiting effectiveness. For the occupant, this means increased forward motion occurs before the seat belts come into effect.

Seat belts are composed of flexible material or webbing that can stretch. Reed et al. found an increase of 130mm of lap and 60mm of shoulder webbing in obese occupants[44]. Larger webbing essentially equates to slack, thus this must be taken up before the belt can be effective, this again results in increased movement of the occupant.

This greater movement in a collision results in a greater risk of the occupant impacting against the interior causing injury. "Submarining" where the body slips below the lap belt, may also occur. Interestingly, Kent et al. conducted cadaveric studies finding that even with optimal seatbelt positioning, the obese experienced more movement[45].

Ineffective seat-belts is not the only challenge that obesity presents to protection systems. Functioning seat belts would not suffice because seat belt use among obese individuals remains lower than the general population[46]. Since 1995, studies have shown a correlation between obesity and lack of seatbelt use in fact in 2002, a study demonstrated an almost linear relationship[47,48]. Studies continue to reiterate this relationship[49,50]. The largest study of this relationship to date was conducted by Jhele et al[51]. They retrospectively analysed 200,000 fatal collisions finding that normal BMI

occupants were 66 percent more likely to wear a seatbelt. Strengthening this, a recent study revealed how an increase in obesity of 1% is associated with a 0.06% decrease in seat belt use in areas with seat belt laws and a .55% decrease in those areas without laws[49]. While this study had a number of limitations such as poor control of confounders, it is supported by similar studies and gives evidence to the intuitive conclusion that seatbelt use is influenced by both obesity and the law.

In relation to the influence of obesity, discomfort is often cited as a contributory factor[51]. Again, it is clear that seatbelt design did not consider those with an increased BMI. Regarding the influence of laws, Irish drivers who fail to comply with seatbelt regulations can receive 2 penalty points and a fine up to €2000. Despite this, seat belts were not used in over 29% of fatal collisions[47].

Obesity can therefore be seen to challenge the well established convention of the seatbelt. Seat belts are not effective in this population. However, owing to their increased risk, seat belts need to be re-evaluated so that obese people are encouraged to buckle up and redesigned in order for them to receive similar protection.

Recommendations

On reviewing the evidence presented thus far, it cannot be denied that obesity presents novel challenges for road safety. However, while unfamiliar and unchartered it does not necessitate relinquishing a licence. While we have a professional and moral obligation to protect the safety of all road users when assessing fitness to drive, we also must recognise our responsibility to support mobility, quality of life and mental health of all patients. Driving cessation is associated with negative consequences as driving is essential in facilitating mobility, independence, confidence, autonomy and psychological well-being[52,53]. These may already by limited by obesity and further compounded by the fact that public transport may be unappealing to those with a larger BMI, for instance cramped buses or city bike schemes.

It is reasonable to invest effort in maintaining obese drivers on the roads, given it is safe to do so. From the evidence laid out above, it would follow that this effort should be concentrated in the following areas.

First and foremost, protection systems need to be reevaluated from design to law enforcement with an obese individual in mind. For instance, the development of smart seat belts that detect and adapt to weight and position and the testing on crash dummies representative of this cohort for optimal functioning and comfort is ideal. Perhaps more achievable in the short term, currently available, seat

belt expanders need to be advertised, accessible and affordable. Campaigns to encourage seat belt use with stricter law enforcement should also be considered.

Next, high quality research must be undertaken to gather information specific to our road users. By understanding the Irish situation we can provide accurate information, guidance and advice to our doctors and patients. Anecdotally, the Medical Fitness to Drive guidelines have become the first port of call when assessing driving risks[54]. Thus including a section on obesity may place health professionals in a better position to assess this patient cohort comprehensively. Doctors have an ethical and legal obligation to give evidence based advice to drivers where an illness or injury may increase the risk of impairment while driving. While you may not categorise obesity by this means, we must consider that lifestyle can increase the risk of impairment. We should aim to maximise their health and function in order to facilitate driving safety.

As society is changing, so should our practice and thus our education. Fitness to drive forms a part of everyday practice however current medical curriculums fail to touch on the subject. Medical education has failed to keep up with the changing population. While most Irish doctors are satisfied some report that although interested, they do not receive adequate training and thus lack knowledge and confidence[55]. Any meeting with a healthcare professional has the potential to be an impetus for change. By equipping them with information on how obesity may have implications for their road safety, this may provide an extra stimulus for change, navigate towards a healthier lifestyle.

Mary Ward, was first known for her use of the microscope to examine the intricate detail of everyday creatures, she later become known for her use of the telescope to observe distant stars. We should follow her progressive example, by closely examining the obesity epidemic that is right before our eyes whilst preparing for the challenges that are forming in the distance.

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Word Count 3100 (including headings)

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