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Driver education: Enhancing knowledge of sleep, fatigue and risky behaviour to improve decision making in young drivers☆

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ABSTRACT

This study assessed the impact of an education program on knowledge of sleepiness and driving behaviour in young adult drivers and their performance and behaviour during simulated night driving.

Thirty-four participants (18–26 years old) were randomized to receive either a four-week education program about sleep and driving or a control condition. A series of questionnaires were administered to assess knowledge of factors affecting sleep and driving before and after the four-week education program. Participants also completed a two hour driving simulator task at 1am after 17 h of extended wakefulness to assess the impact on driving behaviour.

There was an increase in circadian rhythm knowledge in the intervention group following the education program. Self-reported risky behaviour increased in the control group with no changes in other aspects of sleep knowledge. There were no significant differences in proportion of intervention and control participants who had microsleeps ($p \leq .096$), stopped driving due to sleepiness ($p = .107$), recorded objective episodes of drowsiness ($p = .455$), and crashed ($p = .761$), although there was a trend towards more control participants having microsleeps and stopping driving. Those in the intervention group reported higher subjective sleepiness at the end of the drive [M = 6.25, SD = 3.83, $t(31) = 2.15$, $p = .05$] and were more likely to indicate that they would stop driving [M = 3.08, SD = 1.16, $t(31) = 2.24$, $p = .04$].

The education program improved some aspects of driver knowledge about sleep and safety. The results also suggested that the education program lead to an increased awareness of sleepiness. Education about sleep and driving could reduce the risk of drowsy driving and associated road trauma in young drivers, but requires evaluation in a broader sample with assessment of real world driving outcomes.

1. Introduction

In 2010, the global road fatality toll reached approximately 1.24 million, the injury toll reached 30–50 million, and the estimated total cost of fatal and serious injury was US$1855 billion (World Health Organisation, 2013). In Australia, the estimated cost of road trauma is in excess of AU$27 billion and the fatality toll reached 1205 in 2015 (Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016). Approximately 20%–30% of motor vehicle accidents (MVAs) are caused by sleepiness related fatigue as a result of inadequate sleep, extended duration of wakefulness, driving during circadian nadir and/or sleep disorders (Clarke et al., 2010, Horne and Reyner, 1995; Connor et al., 2002; Martiniuk et al., 2013; Pizza et al., 2010). The sleepiness impairs alertness, concentration and reaction time, and increases the risk of microsleeps. Sleepiness related MVAs are also more likely to result in death or severe injuries (Boyle et al., 2008; Bunn et al., 2005).

Young people (25 years≤) are at particularly high risk for MVAs, including sleepiness related crashes (Pack et al., 1995). Lack of experience and risk taking behaviours such as recklessness, speeding, and drug and alcohol use contribute to MVA risk in this population (Clarke et al., 2010; Hung and Winston, 2011). In addition, increased social pressures, academic and work demands, and maturational changes experienced during adolescence and early adulthood can lead to sleep deprivation, and in turn, increase the risk of sleepiness-related MVAs

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(Millman, 2005; Carskadon and Acebo, 2002). Indeed, drivers aged 18–24 are 5–10 times more likely to be involved in a MVA at night (Akestedt and Kecklund, 2001), and male drivers aged 25 or younger are three times more likely to die from a MVA (BITRE, 2012; Toroyan & Peden, 2007) than female drivers. Furthermore, 31% of all young driver fatalities in Australia occur between midnight and 6 a.m. (BITRE, 2009).

While subjective sleepiness is correlated with objective sleepiness (Horne, & Baulk, 2004; Connor et al., 2002), individuals often fail to accurately predict, identify or act on sleepiness while driving (Kaplan et al., 2007). Educating individuals about more specific signs and risk factors for drowsiness and fatigue may help improve driver recognition of sleepiness and decision making (Howard et al., 2014). Education in conjunction with modifying attitudes has been shown to modify speeding behaviour and hazard perception (Fisher et al., 2006; Parker et al., 1996).

This study assessed the impact of an intensive education program on knowledge of sleep and sleepiness in relation to driving in young adults, along with whether the program altered their driving performance and decisions to continue driving while impacted by sleepiness, following a period of extended wakefulness.

2. Methods

2.1. Participants

Thirty-four young adults (18–26) were recruited from Victoria University, Australia. Young drivers were selected because research shows that this group is the most traffic accident prone group due to sleepiness (Pack et al., 1995). Exclusion criteria included; epilepsy, insulin dependent diabetes, chronic psychiatric illness, visual impairment not corrected by wearing eye-glasses, inability to read or write English, five or more caffeinated drinks per day, ten or more cigarettes per day, and significant daytime sleepiness (Epworth Sleepiness Scale score > 15). Inclusion criteria included; aged 18–26, Australian Driver's License, access to a motor vehicle and computer. Ethical approval was granted by the Austin Health Human Research Ethics Committee.

2.2. Design

A randomised, controlled, parallel group trial was used to assess the impact of a sleep and driving education program on sleep and driving knowledge and decision making during simulated driving. Participation began with an hour briefing session where the participants were consented, completed baseline questionnaires to assess knowledge related to sleep, driving and risk taking behaviour (IBAS-DAQ, ESS, and MAPS, refer to Section 2.3 for details), and had a ten-minute practice session on the simulator. The participants were also randomised into and completed the intervention/control conditions (see details in Section 2.4). During the following two weeks, participants reviewed the educational and control material at least three times, and completed an online questionnaire of fifteen multiple choice questions to assess their knowledge and assist with learning.

One month later participants undertook repeat assessment of sleep and driving knowledge and a simulated driving session. During this session, participants were required to restrict their sleep to 5 h. To ensure adherence they called an answering machine at 2 a.m. before going to bed and again upon waking at 7 a.m. (Vakulin et al., 2007). Participants then attended the Sleep Laboratory from 9 p.m that evening until 3 a.m., where they completed the repeat assessment of sleep and driving knowledge (IBAS-DAQ), undertook a ten-minute practice drive and were fitted with an Optalert device (Wilkinson et al., 2013). They were allowed to engage in passive activities, but remained awake at all times. At approximately 1 a.m. (18 h awake), the EEG leads were attached and the participant was briefed about the drive conditions. Following this, they completed the two-hour simulated drive (see Section 2.5 for a description). Fig. 1 illustrates the procedure of this study in diagrammatic form.

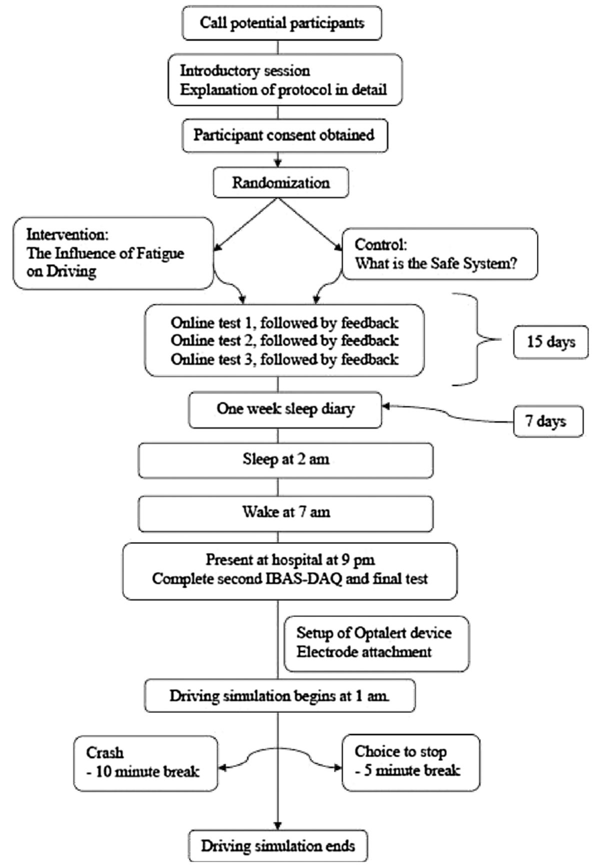

Fig. 1. Procedure of Study.

There were incentives to complete the two-hour drive, but also to undertake the drive in a safe fashion. Participants were advised to stop driving to take a 5 min break at any time if they felt too sleepy to drive safely. They also had to take a compulsory 10 min break if they had a crash. They could not nap, consume any stimulants or perform any strenuous activity during breaks; Participants were told that the breaks did not count towards the 2 h of driving time. Hence, there was an incentive to minimise breaks and crashes to finish the drive as quickly as possible. Although participants were not advised in advance, the drive was terminated at 4 a.m. regardless of total driving time or breaks. Objective sleepiness questionnaires were completed at drive completion defined by; 2 h drive completion, decision to stop driving completely, or termination at 4 a.m. Participants were reimbursed $200.00 for completing the study, $100.00 if they elected to stop driving prior to the end of the drive. The participant with the lowest number of crashes, lane and speed deviations throughout the drive received a $200 gift-voucher.

2.3. Measures

2.3.1. Demographic measures

Demographic and vehicle use information were obtained from part one (items 1–15) of the Institute for Breathing and Sleep Driver Awareness Questionnaire (IBAS-DAQ) (Cortes-Simonet et al., 2010; Kennedy et al., 2008). This included participant's age, gender, occupation, smoking status, alcohol consumption, preferred sleep pattern, hours driven per week, kilometres driven since obtaining provisional licence and learners permit, percentage of reason for driving (work, social) and percentage of driver/passenger scenarios.

2.3.2. Assessment of knowledge and risk taking behaviour

Part two of the IBAS-DAQ contained 94 questions within five Subscales assessing subjective measures of risky attitude towards driving (subscale 1, 17 items), risky driving behaviour (subscale 2, 19 items), sleep behaviour knowledge (subscale 3, 14 items), circadian rhythms knowledge (subscale 4, 24 items), and sleepiness symptoms knowledge (subscale 5, 20 items). Participants responded on a five-point scale on Subscales 1, 3, 4 and, 5 (1 = Strongly Agree to 5 = Strongly Disagree). Subscale 2 indicated how often a particular behaviour was performed (1 = Always to 5 = Never). A lower score in the risk subscale indicated riskier attitudes or behaviours and a higher score within knowledge subscales indicated greater knowledge (a = 0.92) (Cortes-Simonet et al., 2010; Kennedy et al., 2008).

2.4. Intervention: sleep education and control program education materials

2.4.1. Driving and fatigue program – the influence of fatigue on driving (intervention group)

This is a CD-based program that was designed by the Victorian Institute of Forensic Medicine to provide three learning and self-assessment modules. Module 1: The Science of Fatigue included four components; About Fatigue, How Much is Enough Sleep, Sleep Disorders, and Circadian Rhythms and Your Biological Clock. It was specifically designed for recently licensed adolescents and provides key information about fatigue and sleep debt, and the effects on driving at the circadian nadir. Module 2: Wheels at Last contained factual information of young drivers and sleepiness, process and skills involved in driving, and impacts fatigue has on driving. Module 3: Drive to Stay Alive focussed on planning to avoid driving when fatigued. A short series of power point slides provided information specific to sleepiness symptoms considered dangerous to continued driving.

2.4.2. What is the safe system?(control group)

Designed by VicRoads, the CD informed the control group about the human body's tolerance to withstand external forces during MVA impact based on safety improvements to vehicles, roads, and safer speed limits. Drowsiness was mentioned once regarding drug, alcohol and fatigue influences during this pseudo-education.

2.5. Experimental Driving task at final assessment

AusEd© Driving simulator: This is a monotonous rural night time driving task sensitive to performance impairment associated with sleep deprivation and circadian rhythms (Desai et al., 2007). The task was undertaken for 2 h. Variation in speed and lane position, and number of crashes during the task were assessed. A crash event included driving off-road, stopping for more than 5 s, and failure to break sharply each time a truck presented (40 times throughout the drive). AusEd was installed on a Windows 2000 Workstation, displayed on a 19 inch digital monitor, using MOMO Force-feedback wheel and pedals (Desai et al., 2007).

2.5.1. Sleep measures during the driving simulation

The following subjective measures were recorded following the driving simulation.

2.5.1.1. Karolinska sleepiness scale. This scale assessed how sleepy participants felt at task completion using a nine point scale ranging from 1 = extremely alert to 9 = extremely sleepy-fighting sleep. The subjective sleepiness measure is reliable and highly correlated with objective sleepiness measures based on electroencephalography (Kaida et al., 2006).

2.5.1.2. Sleepiness symptoms questionnaire. This questionnaire assessed subjective physiological symptoms related to driving impairment, such as blurred vision and slow reaction times. Eight questions were answered on seven point scales ranging from 1 = not at all to 7 = most of the time (α = .92) (Howard et al., 2014).

2.5.1.3. Stop driving questionnaire. This two part questionnaire assessed how alert the participant felt to partake in an urban drive (part 1) and a rural drive (part 2). Participants ticked one appropriate statement; 1 = I would continue to drive, 2 = I would continue driving only if pressured to do so, 3 = I would stop driving now even under pressure to continue and 4 = I would have stopped driving some time ago (α = .79).

Ocular and EEG measures of drowsiness were recorded continuously during the driving simulation.

2.5.1.4. Optalert^{TM}. Assessed eyelid closure and opening speed during blinking to calculate a composite score to determine drowsiness levels based on John's Drowsiness Score (JDS) (Johns, 2000). A score of five or more during a one minute period represented severe drowsiness, termed a JDS event in this model. Optalert has been validated against gold standard measures of drowsiness (Wilkinson et al., 2013).

2.5.1.5. Electroencephalography (EEG). Assessed the occurrence of microsleeps from two channel recordings; C3-A2 and OZ-A2. Three seconds or more of alpha and theta activity subsequent to beta activity was defined as a microsleep event, analysed by a sleep scientist at the Austin Hospital for each minute of the task.

2.6. Statistics

Demographic differences between the intervention/control groups at the entry point of the study was analysed with Independent Samples t-test. Pre- and post-intervention measures of the IBAS-DAQ questionnaire between the intervention/control groups were analysed using Repeated Measures Split Plot Analysis of Variance. Independent Samples t-tests were used to analyse average speed and average lane deviation between the intervention/control groups. Chi-square goodness-of-fit analyses examined differences between the intervention/control groups, in relation to how many participants' in each group chose to stop driving, crashed or had severe sleepiness (high JDS or microsleep). This analysis was repeated to assess for any differences related to gender, and sleep type groups. Independent Samples t-tests examined subjective sleepiness measures at drive completion between the intervention/control and gender groups. Statistical Package for the Social Sciences (SPSS-Version 20) was used for all analysis, with alpha of 0.05 indicating statistical significance.

3. Results

Thirty-four young adults (age M = 20.66 ± SD = 1.76) who averaged 26.77 months of probationary driving were recruited and completed the project (Table 1). There were no significant differences in baseline demographics, driving characteristics or sleepiness between the intervention and control groups (Table 1).

Post-hoc tests conducted at the. 05 level showed that pre- intervention, the control group reported significantly higher sleep behaviour knowledge than the intervention group ($p < .05$). Post intervention, there was a significant increase in circadian rhythm knowledge in the intervention ($p < .05$), but not in the control ($p > .05$) (Table 2). There was also a significant increase in risky behaviour in the control ($p < .05$), but not the intervention group post intervention ($p > .05$) (Table 2). There were no within or between group differences in the other sleep and driving knowledge subscales post-intervention.

There were no significant differences between the intervention and control groups in the average variation in speed and lane position throughout the simulated drive (Table 3), or in the number of people who chose to stop driving due to sleepiness ($p = .107$), crashed ($p = .761$), had an episode of severe drowsiness ($p = .455$)or microsleep events ($p = .096$) (Fig. 2).

Table 1
Independent Samples t-test of Intervention and Control Groups for individual characteristics.

	Intervention (n = 21)		Control (n = 13)		Total (n = 34)		Sig (2 tailed)
	M	SD	M	SD	M	SD	p value
Age (years)	20.61	1.56	20.74	2.11	20.66	1.76	.83
ESS	5.57	2.13	6.15	2.91	5.79	2.43	.51
Months Driving L's	42.52	20.01	38.15	24.01	40.85	21.38	.57
Months Driving P's	25.90	19.35	26.92	28.58	26.27	22.69	.90
Weekly Alcohol	3.81	5.37	5.00	5.00	4.26	5.19	.52

Note: MAPS = Multivariate Apnoea Predication Scale, ESS = Epworth Sleepiness Scale, Months Driving L's = Months driving on learners permit, Months Driving P's = Months driving on probationary licence. Weekly Alcohol = number of standard alcohol drinks per week.

Table 2
Repeated Measures Spilt Plot Analysis of Variance Pre- and Post- IBAS-DAQ by Intervention and Control Groups.

	Pre				Post					
	Intervention (n = 21)		Control (n = 13)		Intervention (n = 21)		Control (n = 13)		Within Group	Between Group
	M	SD	M	SD	M	SD	M	SD	p value	p value
RA	37.81	5.48	40.00	4.47	38.38	6.241	38.23	6.76	.06	.60
RB	72.71	10.31	79.85	5.59	72.86	10.97	75.54	7.34	.04[b]	.12
SBK	50.00	6.33	54.31	5.64	50.90	4.19	53.92	5.25	.31	.05[c]
CRK	79.19	8.57	83.38	10.28	84.14	7.79	82.23	11.51	.04[a]	.70
SSK	79.52	6.18	83.00	7.91	80.95	7.44	83.38	9.02	.62	.23

Note. RA = Risky Attitude, RB = Risky Behaviour, SBK = Sleep Behaviour Knowledge, CRK = Circadian Rhythm Knowledge, SSK = Sleepiness Symptoms Knowledge. Lower scores indicate increased risky behaviour. Higher scores indicate more knowledge.
[a] only intervention group change.
[b] only control group change.
[c] significant difference between groups at pre and post intervention.

Table 3
Independent Samplest-test between the Intervention and Control Groups for average speed and average lane deviation.

Condition Group	Intervention (n = 21)		Control (n = 13)		Total (n = 34)		Sig (2-tailed)
	M	SD	M	SD	M	SD	p value
Average Speed Deviation	2.50	1.58	2.76	1.11	2.59	1.41	.61
Average Lane Deviation	70.82	30.32	65.96	28.11	68.96	29.16	.64

No significant differences were reported between genders in stopped driving due to sleepiness ($p = .398$), crashes ($p = .104$), have episodes of severe drowsiness ($p = .363$) or microsleeps ($p = .730$) (Fig. 3).

Regarding sleep groups (Fig. 4), the results showed no significant differences in drivers stopping due to sleepiness ($p = .073$), crashes ($p = .092$), episodes of severe drowsiness ($p = .840$) or microsleep events ($p = .411$).

The third stage of analysis examined subjective sleep measures between the intervention and control, and gender groups. Table 4 shows no significant difference between the intervention and control group for the SSQ and SDQ Part 1(short distance drive). However, the intervention group reported significantly higher levels of sleepiness than the control group at completion of the simulator driving task. Furthermore, the intervention group were more likely to state that they would not continue driving on a protracted drive after completing the simulation session due to tiredness in comparison to the control group. Finally, females reported significant higher scores on all four questionnaires (Table 5).

4. Discussion

An intensive education program addressing sleep and driving improved circadian rhythm knowledge in young drivers, but did not alter attitude to risk taking or other sleep related knowledge. There was a trend towards participants in the control group choosing to stop driving due to severe sleepiness more than the intervention group during a simulated night drive, even though the intervention group self-reported a higher level of sleepiness after the drive. However, there was also a trend towards participants in the control group having more microsleeps, suggesting that the intervention group may have better prepared themselves for the night time drive. However, this result is still inconclusive, and future studies with more participants are needed for further clarification.

Circadian rhythm knowledge increased in the intervention group but decreased in the control group, post- intervention. There were no post-intervention improvements in risky behaviour, risky attitude, sleep behaviour knowledge or sleepiness symptoms knowledge in the intervention group. The circadian rhythm knowledge increase could be beneficial in teaching young drivers about the importance of the risk of driving during the circadian nadir (usually night time) when sleep propensity and crash risk are high (Folkard, 1997; Merrow & Brunner, 2011). Young adults are 5–10 times more likely to have a road crash at night when their circadian sleep propensity is increasing and hence an intervention to reduce drowsiness related crashes in this high risk population has the potential to substantially reduce accidents, injuries and associated costs (Akestedt and Kecklund, 2001; Folkard, 1997). Rajaratnam et al., (2015) assessed the effects of more stringent penalties for unsupervised driving at night, coupled with driver education

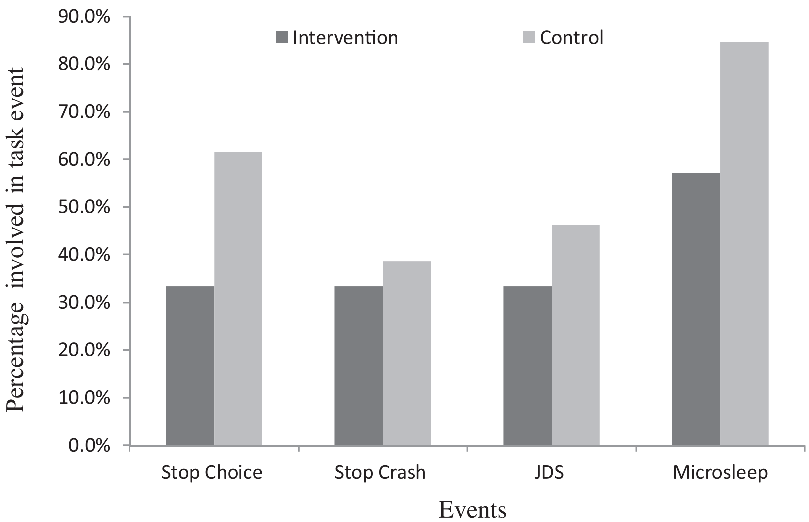

Fig. 2. Percentage of participants involved in an event of stop choice, stop crash, JDS, and microsleep by intervention and control groups.

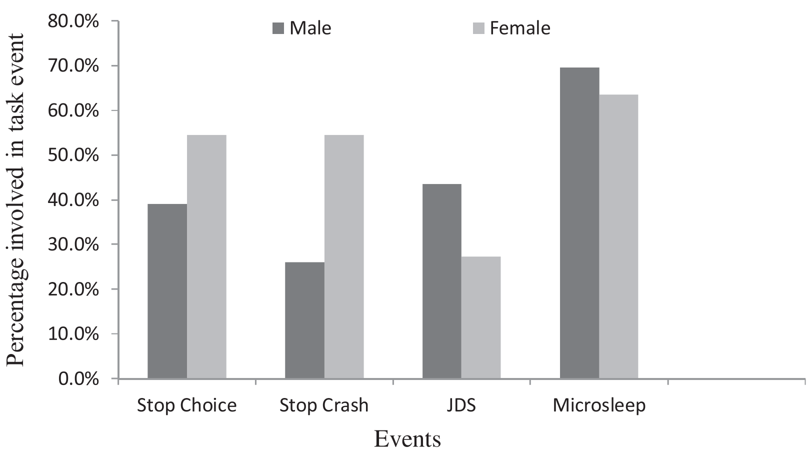

Fig. 3. Percentage of participants involved in a driving simulator task event of stop choice, stop crash, JDS, and microsleep by gender groups.

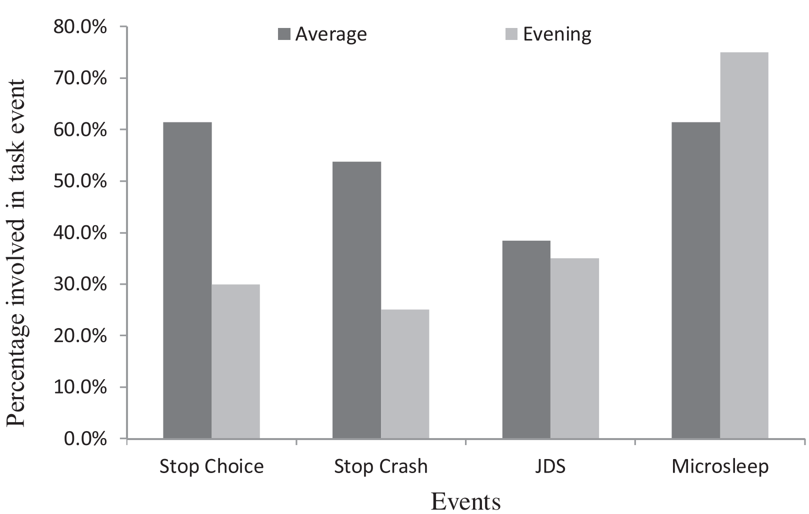

Fig. 4. Percentage of participants involved in a driving simulator task event of stop choice, stop crash, JDS, and microsleep by sleep type groups.

(including drowsy driving education). They found reduced crash risk in drivers aged 16½–17 by 19.1% for all crashes, 39.8% for crashes resulting in fatal or incapacitating injury, and 28.8% for night crashes, relative to a control group of 20 year olds.

The study participants were drawn from a University psychology student population and may have a higher level of knowledge than the general population. This could result in a "ceiling effect" and explain why there was no improvement in other knowledge of sleepiness symptoms and sleep behaviour, but this remains to be assessed in different populations. Interestingly, the control group displayed a significant increase in risky behaviour between their pre- and post-intervention scores, while there was no change in the intervention group. The control group program emphasised motor vehicles and driving environment safety engineering innovations, rather than the importance of good driver behaviour to prevent, recognise and act upon driver drowsiness that was emphasised in the intervention program,

Table 4
Independent Samples t-test between the Intervention and Control Groups for the Karolinksa, SSQ, SDQ Part 1, and SDQ Part 2.

	Intervention (n = 21)		Control(n = 12)		Sig (2 tailed) p value
	M	SD	M	SD	
Karolinksa Questionnaire	8.05	.80	6.25	3.83	.05
Sleepiness Symptoms Questionnaire	35.95	1.02	33.25	15.86	.57
Stop Drive Questionnaire Part 1	3.38	1.02	2.58	1.38	.10
Stop Drive Questionnaire Part 2	3.86	.36	3.08	1.16	.04

Table 5
Independent Samplest-test between the gender groups for the Karolinksa, SSQ, SDQ Part 1, and SDQ Part 2.

	Male (n = 22)		Female (n = 11)		Sig (2 tailed) p value
	M	SD	M	SD	
Karolinksa Questionnaire	6.86	2.10	8.45	.69	.005
Sleepiness Symptoms Questionnaire	30.73	11.88	43.45	11.07	.006
Stop Drive Questionnaire Part 1	2.82	1.33	3.64	.67	.03
Stop Drive Questionnaire Part 2	3.41	.95	3.91	.30	.03

which may explain this difference.

Contrary to the second hypothesis choosing to stop driving due to sleepiness tended to be more frequent in the control group during the driving simulation. Interestingly, the control group tended to have more microsleeps, which indicator severe sleepiness and predictor driver impairment (Jackson et al., 2016). Severe sleepiness is a common cause of road crashes, although we did not clearly identify a higher rate of crashes in the control group during the driving simulation and other aspects of driving performance that are affected by sleepiness were similar in both groups (Boyle et al., 2008; Lyznicki et al., 1998; May, 2011; Clarke et al., 2005; Clarke et al., 2010). Young drivers are at higher risk of sleepiness related crashes than older drivers, although the reason for this is not clear (Pack et al., 1995). Increased exposure to driving while sleepy (such as driving at night), poor preparation for driving such as inadequate prior sleep or making poor decisions about when to drive or stop driving might influence this risk. Limited knowledge about sleep and driving and risk taking behaviour could contribute to these risk factors. The intervention group may have prepared better for the sleep deprived driving session, for example by sleeping more in the week preceding the drive, a potential explanation for tendency towards fewer microsleeps in the intervention group. The intervention group reported higher subjective sleepiness scores and were more likely to indicate that they were not fit to drive than the control group after the simulate night drive, despite the trend towards lower levels of objectively measured sleepiness. This suggests that the education program was beneficial in enhancing awareness of sleepiness at the end of the driving task and altered the young drivers' perception of future driving risk, in line with previous work suggesting knowledge can provide young drivers with better insight into making decisions about potential hazards future behavioural choices (Fisher et al., 2006; Parker et al., 1996). Future research could determine whether a similar education program changes sleep behaviour at home.

There were no significant differences between the genders in choosing to stop driving due to sleepiness, but there was a trend towards females having more crashes. Previous research in partially sleep deprived Australian young drivers has found that females more accurately predict crash risk than males, suggesting that females are either more perceptive of increased crash risk or willing admit to driving limitations (Banks et al., 2004). Alternatively, this finding may reflect differences in baseline performance on driving simulation, which was not tested in this study. Previous research has identified gender related differences in vehicle handling skills, supporting this concept whereas male driver accidents largely result from higher risk-taking behaviour (Laapotti & Keskinen, 1998; Vassallo et al., 2007). There was no significant difference between the genders in objectively measured episodes of severe drowsiness or microsleeps, even though females reported higher levels of subjective sleepiness, suggesting that males had relatively reduced perception of sleepiness symptoms (Howard et al., 2014). These findings, in addition to the recognised increase in risk taking behaviour in males, may explain why there was a trend towards males being less likely to stop driving due to sleepiness during the night time driving simulation.

Chronotype refers to a self-report account of behaviour, sleep onset and rise time relative to the 24 h day and human circadian rhythm (Alvaro et al., 2017). There was a trend towards participants in the average chronotype to stop driving due to sleepiness and crash more than the evening group. However, no differences in JDS scores and microsleeps were found. The difference in JDS scores contrast previous research in evening chronotypes, where sleep propensity after long periods of wake time builds up slowly and over a longer duration in comparison to the earlier sleep types (Akerstedt, 1990). This difference may be due to the small sample size in the current study. The trend towards crash difference supports research that eveningness chronotypes are adaptable to night or shift work with less difficultly than earlier chronotypes (Akerstedt, 1990; Taillard et al., 2003).

4.1. Strengths and limitations

This project was unique in assessing a range of sleep related knowledge and risk taking behaviour in young drivers and the impact of intensive education on young driver knowledge and behaviour. Participants were fulltime students, which may have influenced baseline knowledge potentially resulting in a ceiling effect in terms of improving knowledge. Within the subscales the scope for improvement ranged from 17 to 31% inclusively on the IBAS-DAQ. The impact of the intervention on driver behaviour was assessed using a simulated task, rather than real driving outcomes (such as crashes or traffic infringements). Furthermore, the study did not determine whether the sleep education program altered the way drivers prepared for the night time drive, for example by extending their sleep duration in the days leading up to the drive. Finally, the short-term measurement of the effectiveness of driver sleepiness awareness may have had a side effect of conditioning the participants. The study emphasis on proper driving techniques and the hazardousness of sleepiness (or inadequate sleep) to driving may have strongly affected the education program group in that they would hesitate to demonstrate unsafe driving habits after receiving the training to please the researchers.

4.2. Conclusion and future directions

Young drivers remain at high risk of injury and death from road crashes with fatigue due to sleepiness a leading cause. In this study an intensive education program about sleep and driving improved some aspects of sleep knowledge in a group of young university students. The intervention tended to reduce the likelihood of severe sleepiness and also enhanced the perception of sleepiness during a simulated night drive, although studies with larger sample sizes are needed to clarify this finding. Further work is also required to identify whether the tendency to reduced sleepiness during simulated driving was due to better preparation for night driving in those who had undertaken the education program or another mechanism. Moreover, longitudinal studies (6 months or a year) are needed to investigate the consolidation of circadian rhythm knowledge and the long-term effects of the program driving habits (either using a simulator or in real life). The potential benefits of such a program on real world driving outcomes remain to be determined.

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