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Differences between males and females in the prediction of smartphone use while driving: Mindfulness and income

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ABSTRACT

Introduction: This study examines the relationship between two variables–mindfulness and income–with regards to their relationship to the use of smartphones by young drivers, which has been known to increase the likelihood of car accidents, endangering young drivers and other road users. The study focuses on the relationship between these variables and the use of smartphones while driving, and how this relationship differs between males and females.

Method: The study sample included 221 young drivers who were legally permitted to drive without supervision. The subjects were first asked to complete questionnaires on mindfulness and income. Next, their smartphone use while driving was monitored over a one-month period. This study is unique as it used an objective smartphone monitoring application (rather than self-reporting) to count the number of times the young participants actually touched their smartphones while driving.

Results: The findings show that the effects of social and personal factors (i.e., income and mindfulness) on the use of smartphones while driving are significant for males but not for females.

Conclusions: Most studies that investigate differences between males and females with respect to safety focus on differences in the averages of safety-related variables (such as safety performance and outcomes). In the current study, however, we identified differences in relationships between variables and demonstrated that what predicts safety-related behavior in males may not be a good predictor for females.

Practical applications: Mindfulness and income can be used to identify male populations that are at risk of using smartphones while driving. Interventions that improve mindfulness can be used to reduce the use of smartphones by male drivers.

1. Introduction

The current study focuses on the use of smartphones while driving. Smartphones are the most prevalent technology in the history of humanity (Lopez- Fernandez et al., 2017). The number of smartphone owners increased from 35 % in 2011 to 68 % just four years later (Anderson, 2015). This ongoing and expanding use of smartphones is the result of the device's widespread presence, mobility, and availability, its ability to satisfy many of our needs and provide multiple functions including communication, social media, internet, photography, music player, navigation, games, and so on (Marty-Dugas et al., 2018). Smartphones have a positive impact, as they increase communications between individuals and organizations (Geser, 2004), help promote a healthy society (Fjeldsoe et al., 2009), and enable minority populations to be more involved in social life (d'Haenens et al., 2007d). However, this ever-increasing use of smartphones comes at a price, and results in negative consequences such as dependency and even addiction (Billieux et al., 2008), and increased risks while driving (White et al., 2004).

Young drivers tend to use their smartphones to a larger degree and are involved in more road accidents, compared with older drivers, due to the formers' lack of driving experience and tendency to take risks (Deery, 1999; Finn and Bragg, 1986). The combination of these factors poses a significant safety issue, placing this group of drivers at greater risk of being involved in a car accident (Nemme and White, 2010). Although using smartphones while driving is highly distractive, it is becoming increasingly more widespread among the population in general, and among young drivers in particular (O'Brien et al., 2014). In addition to high-speed driving and driving under the influence of alcohol, this phenomenon is now one of the leading risk factors of fatal or

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serious road accidents, which have a significant negative effect on the economy and on society at large (NSC, 2010; WHO, 2011).

The literature describes differences between the behavior and capabilities of males and females, with most studies analyzing differences in levels of safe behavior or technological usage (Barlett and Coyne, 2014; Elvik, 2010; Kimbrough et al., 2013; Lane and Manner, 2011). Research results indicate a need to further study these differences in greater depth to determine whether males and females differ in the relationship between antecedents of safe behavior and actual behavior (Wickens et al., 2012). To that end, the current study focus on differences between males and females with respect to the prediction of smartphone use while driving, rather than focusing on the behavior itself, as in previous studies. We focus on two predictors, *mindfulness*, which is a personality factor, and *level of income*, which is a socio-economic factor. The current study contributes by focusing on mindfulness, which is a new aspect in the field of safety in general, and of road safety in particular.

2. Smartphones, road safety, and gender

Most studies examine differences between males and females with respect to road safety or technological usage. In general, people use their smartphones as a technological means of communication and social expression. Lane and Manner (2011), for example, found that females spend more time using their phones as a means for maintaining social ties with their peers and family, while males use their smartphone as a means for obtaining information. Moreover, females use text messaging, social communications, and online video calls more than do males (Kimbrough et al., 2013; Muscanell and Guadagno, 2012). In other words, females tend to use smartphones to maintain social and interpersonal relationships, while males tend to use them for functional task-related purposes (Weiser, 2000). Since social communication is a central reason for using smartphones while driving, females are expected to use their smartphone more than males while driving.

3. Mindfulness and the use of smartphones while driving

One variable that could explain the difference in the use of smartphones while driving among young people is mindfulness. This term is defined as the conscious noticing and recognition in the present and the individual's experience of the present in a non-judgmental or interpretive manner (Brown and Ryan, 2003). Theoreticians describe practices of mindfulness as a means for eliminating noises from our thoughts and improving our quality of life (Kabat-Zinn, 2003). As such, people with a low degree of mindfulness tend to report higher mental stress and lower mental wellbeing (Baer et al., 2004; Janssen et al., 2018; Ramli et al., 2018). Although mindfulness is a new concept in the field of safety, it is especially important when dealing with complex tasks such as driving (Vicente et al., 2004). Indeed, several studies have already examined the relationship between mindfulness and safety in general, and road safety in particular. A relationship between mindfulness and road safety may, however, seem obvious, as drivers need to concentrate on their driving, pay attention to traffic, and be aware of the road dynamics at every given moment – or in other words, they need to be mindful (Hanan et al., 2010; Koppel et al., 2019).

As mentioned, distractions have a direct negative effect on the safety of drivers and other road users. Young and Regan (2007) described a similarity between being distracted and lack of mindfulness. Just as being distracted is a result of an event that interferes with the driver's attention and ability to carry out the task of driving safely, lack of mindfulness results from a lack of attention to the task of driving safely. In their study, Feldman et al. (2011) examined the relationship between mindfulness and the self-reporting of students regarding their use of smartphones while driving. Their findings show that students with a low degree of mindfulness reported a higher rate of smartphone use while driving, and vice versa. This correlation between mindfulness and safe driving was also found in a study conducted by Panek et al. (2015), whereby the higher the degree of mindfulness, the lower the extent of smartphone use while driving or walking.

Studies also show that people with a higher degree of mindfulness are more capable of dealing with a range of thoughts and emotions, and are able to “refine” and focus on their desires and motivations (Anari and Shafiei, 2016). As such, people with a high degree of mindfulness may be more capable of exercising restraint and avoidance with regards to using their smartphone while driving, compared with people with lower degrees of mindfulness.

4. Level of income and the use of smartphones while driving

Studies show that drivers of low socio-economic status, regardless of age, are at higher risk of being involved in road accidents (Males, 2009; Shahbazi et al., 2019) and are hospitalized due to road accidents twice as often as people of high socio-economic status (Chen et al., 2010). Low socio-economic status may lead to decreased concentration on safety and increased focus on other "more pressing" issues, such as economic difficulties (Dang et al., 2015).

Drivers who use smartphones while driving place themselves and other road users at risk of being involved in a car accident. Because of the tendency of low socio-economic status to take risks and to suffer more injuries due to car accidents, their use of smartphones while driving may be greater than that of drivers of high socio-economic status.

5. Do males differ from females in the relationship between their traits and smartphones use while driving?

Differences between males and females can be better understood by studying the differences in the relationships between antecedents and behaviors in each of the two populations. Researchers in other fields found, for example, that the impact of a person's socioeconomic status on academic self-concept was greater among female students than among male students (Fin and Ishak, 2012), that negative relationships between emotional intelligence and depression are more prevalent among males than among females (Salguero et al., 2012), and that the relationship between ease of application use and SMS adoption was stronger among female users than among male users (Kim et al., 2013).

Since males and females use their smartphones for different purposes while driving, we suggest that different relationships may exist in males and females between the studied antecedents of smartphone use while driving (mindfulness and income) and the actual use of smartphones while driving.

6. The relationship between mindfulness and smartphone use while driving differs in males and females

Drivers who use their smartphones while driving are in a contradictory position. On the one hand, they must concentrate on their driving in order to perform this task safely, and on the other hand, they must also concentrate on their smartphones if they wish to communicate with others while driving. Mindfulness involves two components (Bishop et al., 2004): The first relates to being aware in the present, a trait that should enhance safety and the focus on driving. The second component relates to being accepting of emotions and thoughts, as well as being open minded and curious – traits that could have a negative effect on safety due to the need to maintain social ties, via the smartphone, even while driving.

As mentioned earlier, females tend to use smartphones for social means more than males, who typically use their devices for more task-related purposes (Bisen and Deshpande, 2016; Lane and Manner, 2011; Munderia & Singa, 2018). As a result, the relationship between mindfulness and the use of smartphones while driving may differ in males and females. Components of mindfulness, namely awareness and focus,

may contribute to mindful, male drivers, in that males with higher degrees of mindfulness will avoid using their smartphones, since such behavior interferes with their focus and attention on the task of driving. In females, on the other hand, in addition to the awareness factor, components of mindfulness that relate to social relationships may be more significantly present, thereby contributing to openness and curiosity and to a focus on social and interpersonal aspects via their smartphones while driving. As such, females with higher degrees of mindfulness will not necessarily use their smartphones less while driving.

7. The relationship between income and smartphone use while driving differs in males and females

Patterns and levels of smartphone use differ for different social economic statuses. Findings show that people of low socio-economic status spend more time using the more (Goel et al., 2012) and Facebook (Correa, 2016), and display different patterns of smartphone use compared with people of high socio-economic status. Moreover, students of low socio-economic status use social media to a greater degree and purchase more applications from digital stores compared with students of higher socio-economic status (Correa, 2016; Rahmati et al., 2012). These uses are functional, task-related purposes that are typical to how males use their smartphones (Weiser, 2000), and so the negative effect of income on the use of smartphone while driving may be more pronounced among males than among females.

In sum we hypothesize that:

H1. Females will use their smartphones while driving more than males.

H2. Mindfulness will be negatively related to the use of smartphones while driving.

H3. Income will be negatively related to the use of smartphones while driving.

H4. The relationship between mindfulness and using smartphones while driving will be stronger for males than for females.

H5. The relationship between level of income and use of smartphones while driving will be stronger for males than for females.

8. Methodology

8.1. Participants

This study investigated 240 drivers[1] who volunteered to participate in the study based on an advertisement; one male was excluded from the final analysis due to an incomplete mindfulness questionnaire and 18 participants (8 males and 10 females) were excluded due to technical issues with their application process. In addition, 35 participants (21 males and 14 females) were excluded from the income-related analysis due to their failure to divulge their income. In total, 221 young drivers (186 for the income analysis) were included in the final study (see Table 1): 143 males and 78 females (122 males and 64 females for the income analysis). It is important to note that according to the Central Bureau of Statistic, most of the young drivers in Israel are male (57 %), and in our sample we had a proportion of males that was 8 % higher than their proportion in the general population (65 %). The 221 drivers made a total of 10,658 trips for a total of 182,980 min. The driver who did not complete the mindfulness scale made 31 trips for a total of 331 min. The 35 drivers who would not report their income made 1,658 trips totaling 29,600 min. The participants were aged 17–22 (M = 19.3, SD = 1.68), were legally permitted to drive without supervision, and had a valid driving license for at least three months prior to participating in the study. All of the drivers owned a smartphone with an Android-based operating system, version 4.3 or higher, and they all drove at least two hours a week. The income of the drivers varied and about 40 % of them had average or less-than-average incomes.

Table 1
Descriptive statistics and correlations.

	Variable	M	SD	1	2	3
1	Income	–	–	–		
2	Mindfulness	2.8	.40	**20.**	–	
3	Smartphone use while driving (screen-touches per minute)	1.7	1.4	−.19**	−.10	–

Note: * $p < .05$. ** $p < .01$ (N = 186 for correlations with income; other correlations N = 221). Correlations with income are Spearman correlations, other correlations are Pearson correlations.

8.2. Measures

Smartphone use while driving was measured as the number of screen-touches per minute, as recorded by the Protext Me smartphone application that was adjusted and configured specifically for this research study. The technology was tested repeatedly prior to the study, and the most reliable version was used. Protext Me labels (which are based on near-field communication, NFC) were printed and distributed by mail to each participant, to be placed inside each car, near the driver's seat. The participants were then asked to download the application to their smartphone. Participants were requested to place their smartphones on their personal NFC labels, throughout the study period, each time they drove their car. The NFC label then automatically activated the Protext Me application, identifying the participant as driver, thus avoiding recording the smartphone use of any other family members or people in the car (The research team could monitor the application and ensure it was successfully activated for each participant.) The application then documented the number of times the research participant touched his or her cellphone screen while driving. Since the rational is that each touch of the smartphone while driving, regardless of the reason (texting, dialing a number, etc.), is risky, participants who only touch their smartphones to answer calls had lower scores than those that actually typed messages and used their smartphones for multiple purposes while driving.

Pilot tests conducted during the study to ensure accurate monitoring, examined the reliability of the study variable, i.e. the number of screen touches per minute, with the help of volunteer users and safety experts. As a result of these pilot tests, not all drivers or journeys monitored during the study were included in the final sample. Journeys with at least one of the following characteristics were excluded from the data when calculating this variable: (1) journeys during which neither the GPS nor an alternative navigating application was activated; (2) journeys that lasted less than three minutes; and (3) journeys in which the participants manually stopped the monitoring application as they were passengers rather than drivers. In addition, data gathered during the last minute of each journey was excluded from the analysis, so as not to include smartphone use after parking, when such use is permitted and safe.

Moreover, as a precautionary measure, the application was also able to sense that the participant had begun driving even if the smartphone was not placed on the label. This was achieved through Bluetooth connections and GPS tracking. An additional function was added to

[1] To determine the desirable sample size, a power analysis was conducted using G*Power (Faul et al., 2008). The analysis was based on multiple linear regressions with a small effect size of .15, an alpha of .05, and high power level of .95. The results of the power analysis showed that a minimum of 138 participants would be needed to achieve a high power level for this study. Since we anticipated a challenging field study in which not all participants starting the study would complete all of the tasks, we aimed to recruit 240 subjects.

application so that when the participants were passengers rather than drivers, they could turn off the tracking device so that their smartphone use would not be monitored during that time (i.e., an "I am not the driver" option). This option was given to participants because in the pilot stage we found several participants used public transport (train or bus). Sometimes their GPS detected travel and the smartphone usage monitoring had been activated. In order to prevent this possibility, we decided to allow them to stop the app monitoring in these situations.

Mindfulness - In order to examine mindfulness among the research subjects, participants were asked to complete the Cognitive and Affective Mindfulness Scale-Revised (CAMS-R) Questionnaire (Feldman et al., 2007), that was studied in the context of driving and even in relation to texting while driving (Feldman et al., 2011). Using a 4-point Likert scale (1 = rarely/not at all, 4 = almost always), participants were asked to rate twelve statements according to the degree to which each sentence is personally relevant to them; thus, the higher the rating, the higher the person's mindfulness. It is important to note, that some researchers study mindfulness as a state, purporting that in a specific situation or task, a person can be more or less mindful (Kiken et al., 2015; Lau et al., 2006; Tanay and Bernstein, 2013). In the current study, however, we focused on mindfulness as a trait and aimed to see whether people who tend to be higher in mindfulness are more likely to avoid using their smartphones while driving compared with people who are low on mindfulness. When analyzing the mindfulness variable, Cronbach's alpha coefficient for internal consistency reliability was $0.71 = \alpha$.

Income - The subjects' monthly household income was compared with the average monthly income in Israel, which at that time was about NIS 13,500. The participants were asked to state whether their monthly household income is significantly below the average, slightly below average, average, slightly above average, or significantly above average.

Biological sex - Participants were asked to indicate their sex (male/female) as part of a preliminary questionnaire that contained additional data such as age and place of residence.

8.3. Procedure

Drivers were recruited to the study over a four-month period, either through social media or using the "bring a friend" method (Dishion et al., 1995). Each driver that completed all the required tasks was paid about US$55 for participation. After completing two online questionnaires, one regarding their demographic background and the other on mindfulness, the drivers received a link to download *Protext Me* (Albert and Lotan, 2018), a mobile application that monitors the number of times people touch their smartphone screens while driving. Over a one-month period, this application worked continuously in the background of the participants' mobile phones, automatically noting when each driving session began and ended. The application also recorded the number of times the drivers touched their cellphone screen while driving. The data were automatically saved on a server with limited access, to ensure participants' privacy. The study was approved by the Ethics Committee at the University of Haifa, and all participants signed consent forms. We first analyzed the data with correlations, analyzing the correlations with the total sample and then splitting the sample into two subsamples of males and females. To test our hypotheses, we used the bootstrapping method and analyzed the data using Process software Hays, 2002. This designated software compares 5000 random samples and assesses the significance of relationships with the dependent variable through the bootstrap range, yielding estimates that are parallel to estimates of multiple regression and can be presented by regression equations.

We conducted regression analyses that test the direct relationships of all variables, and two moderation analyses that test the interaction between income/mindfulness and biological sex (each interaction separately, to maximize sample size):

The equations to be estimated in general form are as follows:

Direct effect equation: $Y = \text{intercept} + \beta1*X1 + \beta2*X2 + \beta3*X3 + \varepsilon$

Interaction equation 1: $Y = \text{intercept} + \beta1*X1 + \beta3*X3 + \beta4*(X1*X3) + \varepsilon$

Interaction equation 2: $Y = \text{intercept} + \beta2*X2 + \beta3*X3 + \beta5*(X2*X3) + \varepsilon$

Note: Y = smartphone use while driving; X1 = mindfulness; X2 = income; X3 = biological sex; ε = error

We also compared the results to multiple linear regressions and made sure they were stable across different analysis procedures.

9. Results

Table 1 presents descriptive statistics and correlations between variables. A correlation was found between income and smartphone use (screen-touches per minute) while driving, but not between mindfulness and smartphone use while driving.

Table 2 presents descriptive statistics and correlations between variables for females (above the diagonal) and males (below the diagonal in bold) separately. A negative correlation was found between income level and smartphone use while driving in males but not in females, for whom no correlation was found. Similarly, a negative correlation was found between mindfulness level and smartphone use while driving in males but not in females, for whom again no correlation was found.

Table 3 presents frequencies for the income variable.

The bootstrap process (Hayes, 2012) was used to test the study's hypotheses. The bootstrapping method assesses the significance of the relationship with the dependent variable through the bootstrapping range. Thus, if the range extends from below zero to above zero, the relationship is not significant (results presented in Table 4).

Table 4, Model 1 presents results for the first three hypotheses. The first hypothesis regarding differences in the use of smartphones while driving between males and females was not supported ($\beta = -.05$, NS). The second hypothesis according to which a negative relationship exists between mindfulness and smartphone use while driving was not supported either ($\beta = .-33$, NS). The third hypothesis, which spoke of a negative relationship between income and the use of smartphone while driving, was supported ($\beta = -.28$, $p < 0.01$).

The results of the fourth hypothesis, which suggested that males would exhibit a stronger negative relationship between mindfulness and the use of smartphones while driving was supported (see Model 2 in Table 4), with a significant biological sex-mindfulness interaction term ($\beta = 1.11$, $p < 0.05$). Fig. 1 presents the shape of the interaction. As hypothesized, the relationship between mindfulness and smartphone use while driving was negative for males (and significant, as revealed in a simple slope analysis: $t = -2.6$, $p < 0.01$) but insignificant for

Table 2
Descriptive statistics and correlations for males and females.

	Variable	1	2	3
1	Income	–	.21	.04
2	Mindfulness	**−.19***	–	.09
3	Smartphone use while driving (screen-touches per minute)	**−.32****	**−.21***	–

Note: * $p < .05$. ** $p < .01$; females (above the diagonal); males (below the diagonal in bold); Correlations with income used Spearman correlation (N for men = 122 for females = 64); Correlations for mindfulness used Pearson correlation (N for men = 143; N for females = 78).
Averages and standard deviations for mindfulness were M = 2.86, SD = .39 for males and M = 2.79, SD = .40 for females, and for smartphone use while driving: M = 1.86, SD = 1.44 for males and M = 1.79, SD = 1.47 for females.

Table 3
Frequencies for income variable.

	Total sample	Males	Females
Well below average	10	7	3
Below average	23	16	7
Average	40	22	18
Above average	60	41	19
Well above average	53	36	17
Completed income questionnaires	186	122	64
Did not answer	35	21	17
Total	221	143	78

Table 4
Regression results: Relationships between mindfulness, income, biological sex and smartphone use while driving, and the moderation effect of biological sex.

Predicting Variable	B	*SE*	bootLLCI	bootULCI
Model 1- Direct relationship between the studied variable and the use of smartphones while driving (screen-touches per minute)				
Mindfulness	33.-	26.	−.85	.19
Income	**−.28****	.09	−4.6	−.99
Biological sex	−.05	.18	−.41	.30
* p < .05, ** p < .01 (N = 221)				
Model 2- Interaction between mindfulness and biological sex in the prediction of smartphone use while driving (screen-touches per minute)				
Mindfulness	**−1.88****	0.71	−3.29	−.04
Biological sex	−3.05	1.59	−6.15	.08
Interaction	**1.11***	0.56	0.00	2.22
*p < .05, ** p < .01 (N = 221)				
Model 3- Interaction between income and biological sex in the prediction of smartphone use while driving (screen-touches per minute)				
Income	**−.99****	.29	−1.58	−.40
Biological sex	**−1.78***	.83	−3.40	−.15
Interaction	**.52****	.20	.12	.93
*p < .05, **p < .01 (N = 186)				

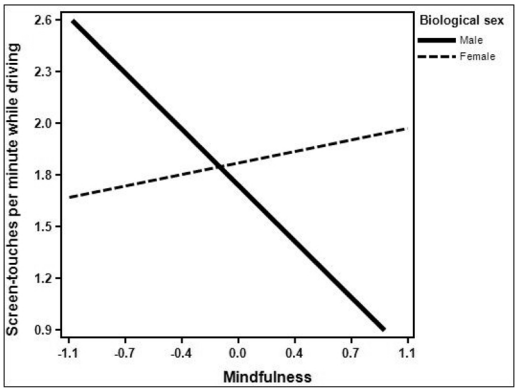

Fig. 1. The moderating effect of biological sex on the relationship between mindfulness and smartphone use while driving (as measured by screen-touches per minute).

females (t = 0.42, NS).

The fifth hypothesis, according to which males should exhibit a stronger negative relationship between income and smartphone use while driving than females was supported (see Model 3 in Table 4), with a significant income- biological sex interaction term (β = .52, p < 0.05). Fig. 2 presents the shape of the interaction. As hypothesized, the relationship between income and the use of smartphones while driving is negative among males (and significant, as revealed in a simple slope analysis: t = −4.33, p < 0.01), but insignificant among females (t = 0.35, NS).

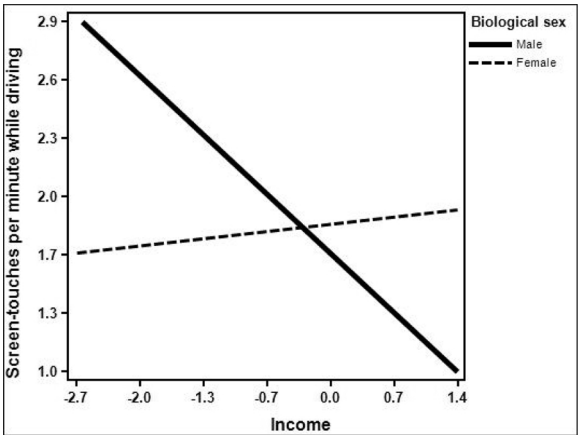

Fig. 2. The moderating effect of biological sex on the relationship between income and smartphone use while driving (as measured by screen-touches per minute).

10. Discussion

This study is unique as it examines how males differ from females in the relationship between two antecedents (income level and mindfulness) and the dangerous use of smartphones while driving. The findings show that the relationship between the antecedent (income or mindfulness) and the use of smartphones while driving was consistently significant only for males (and not for females). Moreover, a negative association was found between income level and smartphone use while driving, while neither mindfulness nor biological sex had a direct relationship with the use of smartphones while driving.

This study is unique in that it measured the drivers' real-time use of smartphones while driving, and so differed from other studies in which data was based on participants' self-reporting (e.g., Dahlen et al., 2012; Herzberg, 2009; Jovanović et al., 2011; Tison et al., 2011). This was achieved through the use of a dedicated passive monitoring tool, i.e., the *Protext Me* mobile application (Albert and Lotan, 2018; Luria and Kita, 2018). It is important to use an objective measuring tool since subjects with high levels of mindfulness might be more aware of their behavior than subjects with low levels of mindfulness and, for the same level of smartphone use, might report higher levels of use than less mindful individuals.

Young drivers use their smartphones for numerous purposes, including texting, social media, and the internet. Doing so while driving endangers both the driver and all other road users. This study found no differences between males and females in the extent of smartphone use while driving, although males and females may be using their smartphones for different purposes. It is possible that females tend to use their smartphones for social purposes, while males tend to use them to obtain information and carry out tasks (Lane and Manner, 2011), and so the differences were not detected by the measure used in the current study, which captured only the number of screen-touches while driving. Another possible explanation is that the hypothesized explanation was based on literature regarding smartphones as a technological means of communication, which predicts that females use their smartphones more than males while driving (Kimbrough et al., 2013; Lane and Manner, 2011; Muscanell and Guadagno, 2012; Oviedo-Trespalacios et al., 2019), while, other differences between males and females, such as risk-taking tendencies, may have influenced the results in the opposite direction. For example, males are known to take more risks when driving and therefore may use their smartphones more than females (Bedard et al., 2002; Kweon and Kockelman, 2003; Schmitt et al., 2002). It is possible that both of these contradicting factors play a role, and as a result no differences were found in the use of smartphones while driving due to a kind of cancelling effect between the two factors.

A difference was, however, found between drivers from households with different levels of income. Thus, young male and female drivers from low-income households use their smartphones while driving to a higher degree than do young drivers from high-income households. This dangerous behavior is in line with studies that found a positive connection between unsafe behaviors and low socio-economic status (Chen et al., 2010; Males, 2009; Rosenbloom et al., 2016). Some researchers explain that financial difficulties can be distracting, shifting the driver's focus from safety-related issues to more pressing monetary issues (Dang et al., 2015). The current study could not determine the content of the use of the smartphone. Future studies should examine the mediating effect of focus on monetary issues on the relationship between income and the use of smartphones while driving.

The past two decades have seen a dramatic increase in mindfulness-based interventions (Creswell, 2017), as well as a wide range of mindfulness-related results and impacts on mental and physical health (Ludwig & Kabat-Zi, 2008), workplaces and organizations (Good et al., 2016), and schools (Sibinga et al., 2016). The field of mindfulness is relatively new with regards to safety in general, and to road safety in particular. Unlike previous studies that revealed a negative relationship between smartphone use while driving (Feldman et al., 2011) or walking (Panek et al., 2015) and mindfulness, this study did not find a direct relationship between mindfulness and the use of smartphones while driving. This lack of relationship may stem from the moderation that the biological sex variable exerts in the relationship between mindfulness and smartphone use while driving. It seems that mindfulness helps males focus on the task of driving but does not help females in a similar way. Based on earlier biological sex research (Friedman et al., 1980; Hall, 1978; Riggio, 1986), we suggest that females may focus more on others and be mindful of their social needs, while males are more mindful of their tasks.

11. Limitations and future directions of research

This study is unique in that the dependent variable, i.e., the use of smartphones while driving, is based on a real-time measure rather than on self-reporting. However, while the tool provides data about the number of times drivers touch their smartphone screens while driving, it does not provide information about the type of smartphone use, nor does it provide input about the specific driving setting, such as the presence of additional passengers in the car or the driving status when the drivers touch their smartphone (e.g., stopped at traffic lights). Such information could offer additional insights into young drivers' use of smartphones while driving.

Moreover, the ability to generalize these findings to populations of all ages is also limited, as the study only analyzed data for young drivers aged 17–22. It is important to note that there is no agreed definition of young drivers in the literature in terms of age range: some researchers consider drivers who are older than 22 (up to 25) to be young drivers (Constantinou et al., 2011; Weston & Hellier, 2018), while others focus on drivers younger than 19 when studying young drivers. In the current study we focused on the age range of 17–22 because we wanted a homogenous sample of young drivers with little driving experience for whom the use of smartphone is extremely dangerous. Studies indicate that road accidents are significantly more frequent in the first year of unsupervised driving (Preusser and Leaf, 2003; Williams, 2003; Prato et al., 2010), which for most drivers in Israel happens within the age range we focused on. The age of the participants in our study seems to capture at-risk young drivers well and gave us a large enough sample size to properly analyze the data. This study did not capture social gender expectations but rather differences that are based on biological sex. Future research should measure social gender expectations in order to investigate the extent to which differences between men and women in their use of smartphones while driving are due to social gender expectations.

The data in the current study was based on a small field project and was therefore limited since it may suffer from heterogeneity. Due to the selective sampling procedure of this study on the one hand, and a limited number of observations on the other hand, it was not possible to correct for heterogeneity in the current study. We suggest that future research replicates our research using a better sampling method, which will also enable the use of more sophisticated statistical, econometric, or machine-learning-based techniques to deal with the potential, unobserved heterogeneity.

The smartphone application used in this research supported only Android-based phones and not IOS-based phones. Sine 75 % of users in Israel use Android-based phones (Mobile Operating System Market Share in Israel - December, 2019), the bias/damage from excluding IOS-based phones is limited. Furthermore, the price range for Android smartphones is wider than for IOS smartphones, making it easier to sample drivers from a wide range of income levels. We suggest that future studies compare between IOS- and Android-based users in regards to smartphone use while driving.

No objective measure of income was available to the research team and so the variable was measured by the participants' subjective report of their own income level. Some participants in our study (35) refused to report their income and so the sample size for the analysis regarding income was smaller than for mindfulness. Furthermore, more young male drivers than young female drivers agreed to participate in the study. Finally, a mixed-method approach (both qualitative and quantitative) could be beneficial for further understanding the patterns of young people's use of smartphones while driving, shedding light on preventive mechanisms and developing means to help young people avoid using smartphones while driving, thereby enhancing their safety.

12. Summary and applications

As the findings show, income level contributes to differences in the use of smartphones while driving – an activity that endangers new drivers and all other road users. Moreover, our results demonstrated that both mindfulness and level of income are related to smartphone use while driving only among males.

The field of mindfulness is becoming more prevalent as an organizational and private means for reducing internal and group conflicts (Yu & Zellmer, 2017). This indicates the importance of developing an intervention model for increasing mindfulness that could in turn enhance our focus while driving in general, and will help decrease distraction regards to the dangerous use of smartphones while driving. The results of this study suggest that mindfulness interventions may be effective in reducing the use of smartphones by male (but not by female) drivers.

The study highlights a population that is at increased risk of accident due to the use of smartphones while driving, namely young drivers with low income. We therefore recommend that interventions for young drivers be developed and offered in schools and communities in neighborhoods and cities characterized by a low socioeconomic status. Since use habits are often preserved over time, young drivers may continue to use their smartphones in the future as adult drivers as well. We believe that focused prevention efforts are needed in order to reduce immediate risk and prevent the development of an unhealthy habit that will be more difficult to break later.

The current study focused on biological sex and didn't measure wider social gender based expectations which can provide another explanation to the results. The term "gender" demonstrates the perception whereby differences between men and women are the result of social structures that create social order. Within this social order, the two sexes play different roles with regards to society, employment, studies, and families. As such, society has different expectations from men and women regarding their roles, behaviors, and more (Eagly and Wood, 1991). In Western society, the family roles of men and women are traditionally and dichotomously divided, whereby men are responsible for providing for their family, while women are responsible for taking

care of the home, children, and family cell (Van De Vijver, 2007). These gender differences exist almost from birth, and our surroundings play an important part in shaping these roles. For example, through discrete socialization processes, norms, behaviors, and expectations, women become more adept at deciphering emotional communications, while men tend to control expression of their emotions (Meece et al., 2006).

The literature shows that gender is also a moderating variable in the relationship between level of income and various aspects of life. For example, gender is a moderator of the relationship between level of income and academic self-perception (Fin and Ishak, 2012). The Social Theory (Eagly, 1987) assumes that people's behavior is predicted by the process of socialization, through which they are shaped by different gender expectations and cultural norms (Zelezny et al., 2000). In this process, women are socialized to be more expressive, to have stronger ethics regarding taking care of others and being concerned for them, to be more cooperative, more sociable, and more helpful (Beutel and Marini, 1995; Chodorow, 1974; Eagly, 1987; Gilligan, 1982). Men, on the other hand, are socialized to be more independent and competitive and to serve financial providers for their families (Chodorow, 1974; Gilligan, 1982; Keller, 1995). Since one of the dominant explanations for the non-safe behavior of people with low income is the increased focus on other, "more pressing" issues, such as economic difficulties (Dang et al., 2015), it is logical that men will be those more affected than women, as they are socialized to find ways to provide.

Author statement

The manuscript is a joint effort of both authors. Both authors worked on all parts of the research together as a team (conceptualization, data analysis, writing, etc.).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.aap.2020.105514.

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