The importance of analogue zeitgebers to reduce digital addictive tendencies in the 21st century

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ABSTRACT

Analogue zeitgebers such as wristwatches and alarm clocks are essential for structuring everyday life. Since the dawn of the digital revolution – particularly since the advent of the smartphone – mobile phones have increasingly replaced analogue zeitgebers as a means of telling time. This functionality may prove problematic, in that it may contribute to the overuse of digital media (e.g. when checking the time turns into extended use of other smartphone utilities, including Internet-based applications). Of N = 3084 participants, 45% reported wearing a wristwatch and 67% used an analogue alarm clock. We observed that participants who reported using analogue zeitgebers used their mobile-/smartphone significantly less. Use of analogue zeitgebers may prove a practical tool for therapeutic and preventative interventions for problematic Internet use in an increasingly digital age.

1. Introduction

Smartphones[1] and readily available Internet access serve to enhance modern life in many ways. Individuals can communicate through a variety of different channels, including voice calls, online social networks and instant messaging, from almost anywhere as long as there is a phone signal. Inbuilt Global Positioning System (GPS) applications enable people to navigate directions, while smartphones also provide a range of entertainment options, including access to computer games, movies and music. Given the multifaceted features of smartphones, it is unsurprising that in Germany alone 40% of the population own such a device (Think with Google, 2013). However, the smartphone is also poised to impact negatively on society.

The dark side of these technological advances is a rise in the number of problematic smartphone users (Kwon et al., 2013; Lapointe et al., 2013) and problems arising from inappropriate use of smartphones in everyday life, e.g. while driving a car (Porter, 2010). It is readily apparent on an everyday basis how engrossed many individuals are in their phones, e.g. while waiting at a bus stop or even when meeting friends at a bar. This phenomenon becomes particularly problematic when individuals focus increasingly on digital devices such as smartphones, to the exclusion of face-to-face social interactions (e.g. Reid and Reid, 2007; Wu et al., 2011).

Although smartphone addiction is not an official diagnosis in the current editions of manuals for psychiatric disorders such as DSM-5 or ICD-10,[2] it may be possible to consider this potential form of addiction through the lens of typical addiction symptomatology. For example, people addicted to their phones spend increasing amounts of time on their smartphone to achieve the same level of satisfaction from digital media consumption (development of tolerance); are preoccupied with their media use and show withdrawal symptoms such as experiencing nervousness/agitation at leaving the smartphone at home. These symptoms have previously been considered in relation to Internet addiction (Tao et al., 2010); a term closely related to smartphone addiction. Indeed, access to the online world is a core feature of smartphones. Although smartphone addiction (similar to Internet addiction) is not currently recognized as an official diagnosis, excessive smartphone use may have a profound negative impact on wellbeing (e.g. Augner and Hacker, 2012; Leung, 2008) and on the way we communicate

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[1] In the present study a smartphone is defined as a more technologically sophisticated phone model within the overarching category of mobile phones, e.g. the iPhone (R).

[2] In the current version of DSM-V only Internet Gaming Disorder, a specific form of Internet addiction (Montag et al., 2015), has been included as an emerging disorder in section III.

Fig. 1. Left picture shows the public exhibition boat called 'MS-Wissenschaft' ('MS-Science'), where the participants were recruited to the present study; right picture shows a tablet with the questionnaires.
Ilja Hendel/Wissenschaft im Dialog.

with others (Kamibeppu and Sugiura, 2005), e.g. several studies have observed a link between low life satisfaction and high Internet addiction (Bozoglan et al., 2013; Cao et al., 2011). This may also be the case for the overuse of smartphones (however, more work is needed on this topic). Also of concern is the way in which the smartphone allows work to permeate every part of an individual's life, invading even the bedroom, with potentially negative effects on sleep and wellbeing. Fittingly, smartphone (over-)consumption has recently been linked to poor sleep quality (Yogesh et al., 2014). Paradoxically, the smartphone also distracts from important daily tasks, including work. Picture yourself sitting in front of your computer with the aim of writing a research paper. If you receive a constant barrage of messages via your smartphone – each possibly accompanied by an auditory alert – your focus will inevitably be diverted from your computer screen to your smartphone again and again. Thus, due to repeated distractions, the important state of (work) flow (Csikszentmihalyi and LeFevre, 1989) cannot be achieved. In a state of flow, a person concentrates deeply on a task and forgets about time and location while being very productive.

One of the most underestimated functions of the smartphone is among its most simple: its use as a zeitgeber or alarm clock. We borrowed the term 'zeitgeber' from a different context – namely chronobiology (e.g. Arendt and Broadway, 1987). Here, we refer to its original German meaning – literally to 'give or show the time'. Internet addicted individuals – and likely also smartphone addicts – typically lack skills in structuring their daily routines, making zeitgeber usage an important area of research for these at-risk groups.

The following study comprised a large-scale investigation of smartphone ownership and use as a zeitgeber among our participants. We also investigated how many participants still owned a wristwatch or alarm clock and how this related to their media consumption. Finally, we asked participants in the present study about their weekly Internet and smartphone use for both leisure and business activities. We hypothesized that analogue zeitgeber ownership/usage would be associated with lower digital consumption in terms of leisure-time Internet and mobile phone use. The same was predicted for Internet addiction tendencies. As the present study was correlational in nature, we asked how often participants would get side-tracked when using the smartphone as a zeitgeber, i.e. become distracted by emails, Internet applications etc., resulting in prolonged smartphone use. Here we hypothesized that greater instances of becoming sidetracked would be associated with higher consumption of digital media.

2. Methods

The present data were collected at a public exhibition called 'MS-Wissenschaft' ('MS-Science'), which traveled on a boat through Germany/Austria in Spring/Summer 2014. The exhibition was organized by the most prestigious governmental research foundations (e.g. the German Research Foundation (DFG)) to encourage public engagement in science (see Fig. 1).

In the context of the present research question, N = 3084 exhibition visitors from all over Germany/Austria (1588 males and 1496 females, mean-age: 29.77 (SD = 17.19)) participated.[3] Education level was assessed from 1 to 7 with 1 = no education and 7 = having completed a university degree. Education level was distributed across the sample as follows: no education = 1 (30.5%),[4] Volks-/Hauptschulabschluss (streamed secondary school for lesser able students) = 2 (6.1%), secondary school leaving certificate (Mittlere Reife) = 3 (21.6%), vocational baccalaureate diploma (Fachabitur) = 4 (5.6%), A-level (Abitur) = 5 (14.7%), university of applied sciences degree (Fachhochschulabschluss) = 6 (7.1%), and university degree (Hochschulabschluss) = 7 (14.4%). Consent to participate in the study was indicated by clicking an 'agree' button, after reading the informed consent and before completion of the online questionnaire. The questionnaire was administered via Samsung Galaxy Note 10.1 tablets. If visitors to the exhibition 'MS-Wissenschaft' did not want to complete the questionnaire on the boat, they were given the option to send a reminder to their private e-mail address and complete the questionnaire later. Details of the questionnaire may be found in the Appendix A and in the next section. Participants' e-mail addresses were not registered. Participation was completely anonymous. The study received approval from the local ethics committee at the University of Bonn, in Germany.

2.1. Questionnaires

Participants were asked whether they owned a smartphone, an analogue alarm clock, usually wear a wristwatch and how much they used the Internet and mobile-/smartphone[5] for private and business purposes. In addition to this, participants completed a questionnaire measuring Internet addiction (short Internet Addiction Test by Pawlikowski et al. (2013)). This questionnaire comprises twelve items assessing problematic Internet use, which range on a 5-point scale from 1 = 'never' to 5 = 'very often'. The total score of the questionnaire ranges from 12 to 60 points. Higher scores indicate more problematic behavior in one's Internet use, such as losing sleep due to high Internet usage or hiding about the actual amount of personal Internet use. Participants were asked how often they became sidetracked by their phones when they 'just' intended to check the time and if they used their mobile-/smartphone as an alarm clock.

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[3] See information on data cleaning in the Supplementary material.
[4] Which could also mean that you are still at school.
[5] In the current paper, to disentangle the terms mobile- and smartphones, we used the term 'mobile phone' for the initial items measuring private or business phone use and asked in subsequent items whether participants owned a smartphone (by which we mean a more sophisticated device than the 'analogue' mobile phone, which facilitates Internet access etc.).

Last but not least, participants were asked how long in minutes after waking up and before going to bed they check their smartphones for 'the first time'/'one last time'. The zeitgeber items are presented in the Appendix A. Several other variables, including personality traits and life satisfaction were assessed, but are not the focus of the present study. The short Internet Addiction Test has previously been validated by Pawlikowski et al. (2013). In contrast, our questionnaire measuring zeitgeber usage was used for the first time in the present study. The statistics on Internet addiction and leisure Internet consumption can be found in the Supplementary material.

3. Results

Of N = 3084 participants, 81% owned a smartphone,[6] 45% reported regularly wearing a wristwatch and 67% reported having an 'actual' alarm clock in their bedroom. 34% reported using their mobile phone as an alarm clock and 11.10% answered that they often or very often became sidetracked by other smartphone utilities when they just wanted to check the time on their phone. Age was significantly associated with many of the variables under investigation (see the Supplementary material for details); we thus report ANCOVA results, where age is included as a covariate.

Wearing a wristwatch significantly predicted the amount of leisure time spent engaged in mobile phone use; participants without a watch were associated with higher personal mobile phone use ($F_{(1,3081)} = 5.88$, p = .02; M = 12.04 (SD = 16.90) vs. M = 8.55 (SD = 14.27)). Similarly, participants who reported not having a 'real' alarm clock in the bedroom used their mobile phone significantly more for leisure activities than participants possessing a 'real' alarm clock ($F_{(1,3081)} = 36.10$, p < .001; M = 13.98 (SD = 18.07) vs. M = 8.77 (SD = 14.38)). Moreover, for those participants who used their mobile phone as an alarm clock, even stronger effects were observed ($F_{(1,3081)} = 99.91$, p < .001; using the phone as an alarm clock M = 14.97 (SD = 18.56) vs. not using the phone as an alarm clock M = 8.15 (SD = 13.72); see Fig. 2). Finally, the item "How often do you 'just' check the time on your phone but become side-tracked, e.g. checking emails?" was linearly associated with weekly mobile phone use for leisure activities ($F_{(4,3078)} = 73.72$, p < .001, see Fig. 3 and Table 1). Analyzing the male and female subsamples separately led to comparable results (for reasons of brevity we don't go into more detail, here). Participants who reported using both a wristwatch and an alarm clock differed strongly from the remaining participants in terms of their leisure mobile phone use: These participants used mobile phones for leisure activities an average of M = 7.39 (SD = 13.09) hours per week compared to a reported average of M = 12.10 (SD = 16.93) hours per week for the rest of the sample ($F_{(1,3081)} = 16.97$, p < .001). Of note, non-parametric testing yielded similar results.

4. Discussion

This study suggests that use of a mobile phone, particularly a smartphone, as an alarm clock is associated with significantly greater personal mobile phone use (about 14.97 h per week, compared to 8.15 h for those with an actual alarm clock). Thus, substituting a smartphone for an alarm clock is associated with 1.8 fold increase in leisure time spent using a mobile phone. As the Supplementary material shows, similar trends can be observed for all leisure-based Internet use (including Internet use on personal computers). As this study is correlational in nature, causal relationships cannot be inferred; thus,

[6] To disentangle the terms mobile- and smartphone, we used the term 'mobile phone' in the items measuring private or business phone use and asked in subsequent items whether participants owned a smartphone (by which we mean a more sophisticated device than the 'analogue' mobile phone, facilitating Internet access etc.). Thus, the term mobile phone refers to the overarching category of which smartphones comprise a subcategory. 81% of participants reported owning a smartphone; thus, for the majority of the sample the term 'mobile phone' is synonymous with smartphone.
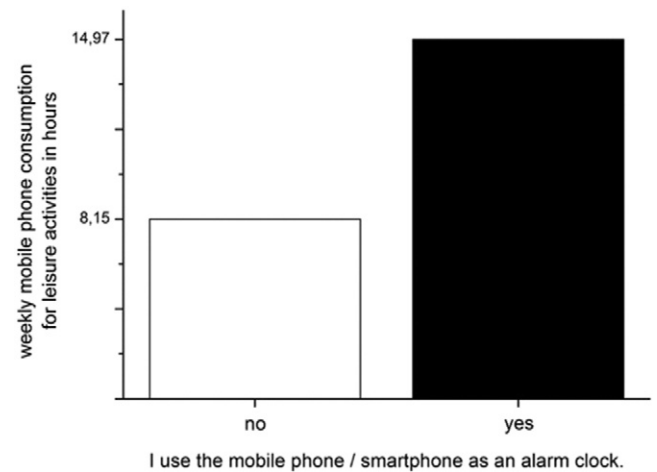

Fig. 2. Using the mobile phone as an alarm clock and leisure time spent on the mobile phone (measured in self-reported weekly hours, means; please see means and standard deviation in the text).

we cannot say that non-use of analogue alarm clocks leads to elevated mobile phone use or Internet consumption. Indeed, the converse may also be true, i.e. use of the alarm clock function on the mobile-/smartphone may reflect general phone or Internet addiction tendencies. In our opinion, it is very likely that mobile phone use in general represents one of many causal mechanisms leading to higher use of the Internet. This hypothesis may be tested by directly asking the participants "How often do you 'just' check the time on your phone only to become side-tracked, e.g. checking emails?" thus, explicitly highlighting the mobile-/smartphone as the source of longer (than intended) Internet use. All relevant variables e.g. weekly mobile phone/Internet consumption for leisure activities and Internet addiction, were strongly influenced by this item, with participants who reported more instances of becoming sidetracked scoring higher on the other variables. For example, those answering with "very often" compared to "never", showed an almost fivefold increase in mobile phone use during leisure time (about 29.36 h per week compared to 5.72 h per week!). To contextualize this finding: at least 8.30% of the present sample answered 'often' and 2.80% 'very often' in response to this question. Following on from our data, the time/clock feature of a mobile phone could be viewed as a gateway application, enticing individuals into prolonged smartphone
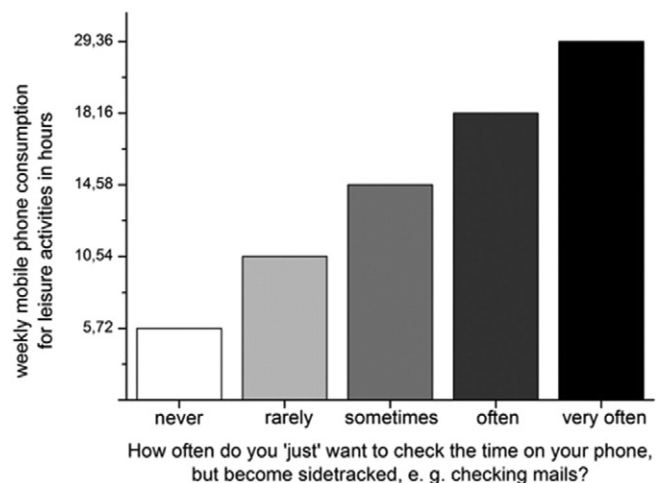

Fig. 3. Association between checking the time on the mobile phone but becoming side-tracked and leisure time spent on the mobile phone (measured in self-reported weekly hours, means; please see means and standard deviations in Table 1).

Table 1
Means and standard deviations accompanying Fig. 3.

	Leisure time on the mobile-/smartphone in hours per week
Never	M = 5.72 (SD = 11.54)
Rarely	M = 10.54 (SD = 14.26)
Sometimes	M = 14.58 (SD = 17.27)
Often	M = 18.16 (SD = 19.58)
Very often	M = 29.36 (SD = 28.30)

use. It needs to be mentioned, that 19% of the present sample reported not owning a smartphone. Thus, the link between analogue zeitgeber usage and digital media consumption discussed here may only apply to the discrete group of smartphone owners. Unsurprisingly, this sub-sample (consisting only of smartphone users) demonstrated a robust association with more instances of becoming sidetracked when checking the time on their smartphone ($F_{(4,2502)} = 45.04$, p < .001; e.g. 9.80% of the present sample answered 'often' and 3.20% 'very often', now).

Based on the present data we argue for the reintroduction and use of analogue zeitgebers to structure everyday life. We do not extend this recommendation to include new products such as digital smart-watches, which can be synchronized with a smartphone and include many functions comparable to those on a smartphone. The reintroduction of analogue zeitgebers is a simple strategy, which could have great impact on the prevention of excessive mobile phone use. The numbers observed in our sample are alarming and suggest that reintroduction of analogue zeitgebers has the potential to make a great positive impact on the everyday lives of at-risk individuals: 55% of the participants reported not wearing a wristwatch most of the time, while 33% did not have an analogue alarm clock.

The advantages of such an intervention are readily apparent: The digital world – including work – would be further removed from the bedroom (36.60% of the smartphone owners reported checking their smartphones in the first 5 min after waking up and 40.70% in the last 5 min before going to bed). The absence of smartphones in the bedroom may give the mind a better chance to come to rest, promoting healthier sleep patterns. This may ultimately help facilitate the cutting down of smartphone and Internet use, which seems to increasingly distract us in everyday life. As reported in the Supplementary material, owning a wristwatch or an alarm clock is strongly associated with age; owners of analogue zeitgeber devices tend to be older than non-owners. Thus, age is a key consideration in the statistical analyses of the current data. In this context, we mention that the results presented are robust and independent of participants' age. Thus, the (re-)introduction of an-alogue zeitgebers is of interest for both younger and older generations.

The present study has three key limitations. First of all, this is not a longitudinal study and due to its cross-sectional nature, causality cannot be inferred with confidence from the present data. It is also worth noting that the data reported herein were collected via self-report questionnaires and therefore the usual limitations of self-report methodologies pertain to the study. In future work we wish to incorporate 'real' life data, rather than relying solely on self-report methods. Some data will always need to be collected via self-report (e.g. the information on wearing an analogue wristwatch), but others can be recorded directly by means of Psychoinformatics, i.e. the application of computer science methods to psychology (Markowetz et al., 2014; Montag et al., 2014; Yarkoni, 2012), e.g. where applications installed on a smartphone can track the human–machine-interaction, such as the frequency of checking one's phone. In this way, we can utilize smartphone applications to gather more accurate data and to help build a clearer picture of the advantages and disadvantages of daily technology use in our increasingly digital society. Despite the usefulness of such methods, however, we still advocate for the benefits to individual wellbeing associated with a reduction in smartphone usage.

Finally, participants in this study were recruited through a public exhibition called 'MS-Wissenschaft' ('MS-Science') that focused on 'digital society'. Therefore, the visitors to this exhibition may be more prone to the overuse of digital devices (this is reflected in the high number of smartphone owners: 81% of the present sample compared to 40% in Germany as reported by Think with Google (2013)). Nevertheless the findings from the current sample clearly show a rising number of people whose lives center around their smartphone and similar devices. It is also noteworthy that we only included the socio-demographic variables age and gender as control variables. In view of the limitations highlighted in this section, our findings need to be considered preliminary and we encourage other researchers to aim to replicate our results.

In sum, the present study investigated the link between owning/using analogue zeitgebers instead of mobile phones as a means of telling time and excessive Internet use. Our work underlines the importance of including information on analogue zeitgeber usage to obtain a better understanding of modern digital life in the 21st century. Based on the evidence considered in this paper, it is vital to find a balance between analogue and digital life by separating these spheres into distinct times and spaces in everyday life.

Conflict of interest

The authors state no conflict of interest.

Authors' disclosures

Appendix A

Mobile phone use as a 'zeitgeber' (showing the time) in daily life. For research purposes we are interested in your answers to the following questions. Please indicate the applicable answers.

I own a smartphone.	Yes	No
I usually wear a wristwatch.	Yes	No
I have an 'actual' alarm clock in my bedroom (rather than a mobile-/smartphone).	Yes	No
I use the mobile-/smartphone as an alarm clock.	Yes	No
I use the mobile-/smartphone to show time.*		

*This item was not included in our survey, but we recommend its use for reasons of completeness in the future.

How often do you 'just' want to check the time on your phone only to become sidetracked, e.g. checking emails?
Answer: Never – seldom – sometimes – often – very often or not applicable.
How soon after waking do you typically use your phone for the first time (range between 0 and 59 min could be chosen/or not applicable)?
Minutes: or not applicable.
How shortly before going to sleep do you typically check your phone for one last time (range between 0 and 59 min could be chosen/or not applicable)?
Minutes: or not applicable.

Appendix B. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.abrep.2015.04.002.

References

Arendt, J., & Broadway, J. (1987). Light and melatonin as zeitgebers in man. *Chronobiol. Int.*, 4, 273–282.

Augner, C., & Hacker, G. W. (2012). Associations between problematic mobile phone use and psychological parameters in young adults. *Int. J. Public Health*, 57, 437–441.

Bozoglan, B., Demirer, V., & Sahin, I. (2013). Loneliness, self-esteem, and life satisfaction as predictors of Internet addiction: A cross-sectional study among Turkish university students. *Scand. J. Psychol.*, 54(4), 313–319.

Cao, H., Sun, Y., Wan, Y., Hao, J., & Tao, F. (2011). Problematic Internet use in Chinese adolescents and its relation to psychosomatic symptoms and life satisfaction. *BMC Public Health*, 11(1), 802.

Csikszentmihalyi, M., & LeFevre, J. (1989). Optimal experience in work and leisure. *J. Pers. Soc. Psychol.*, 56, 815–822.

Kamibeppu, K., & Sugiura, H. (2005). Impact of the mobile phone on junior high-school students' friendships in the Tokyo metropolitan area. *Cyberpsychol. Behav.*, 8, 121–130.

Kwon, M., Lee, J. Y., Won, W. Y., Park, J. W., Min, J. A., et al. (2013). Development and validation of a smartphone addiction scale (SAS). *PLoS One*, 8, e56936.

Lapointe, L., Boudreau-Pinsonneault, C., & Vaghefi, I. (2013). Is smartphone usage truly smart? A qualitative investigation of IT addictive behaviors. *System Sciences (HICSS), 2013 46th Hawaii International Conference on* (pp. 1063–1072). IEEE.

Leung, L. (2008). Linking psychological attributes to addiction and improper use of the mobile phone among adolescents in Hong Kong. *J. Child. Media*, 2, 93–113.

Markowetz, A., Błaszkiewicz, K., Montag, C., Switala, C., & Schlaepfer, T. E. (2014). Psycho-informatics: Big data shaping modern psychometrics. *Med. Hypotheses*, 82, 405–411.

Montag, C., Błaszkiewicz, K., Lachmann, B., Andone, I., Sariyska, R., et al. (2014). Correlating personality and actual phone usage: Evidence from psychoinformatics. *J. Individ. Differ.*, 35, 158–165.

Montag, C., Bey, K., Sha, P., Li, M., Chen, Y. F., Liu, W. Y., & Reuter, M. (2015). Is it meaningful to distinguish between generalized and specific Internet addiction? Evidence from a cross-cultural study from Germany, Sweden, Taiwan and China. *Asia Pac. Psychiatry*, 7, 20–26.

Pawlikowski, M., Altstötter-Gleich, C., & Brand, M. (2013). Validation and psychometric properties of a short version of Young's Internet Addiction Test. *Comput. Hum. Behav.*, 29, 1212–1223.

Porter, G. (2010). Alleviating the "dark side" of smart phone use. *Technology and Society (ISTAS), 2010 IEEE International Symposium on* (pp. 435–440). IEEE.

Reid, D. J., & Reid, F. J. (2007). Text or talk? Social anxiety, loneliness, and divergent preferences for cell phone use. *CyberPsychol. Behav.*, 10, 424–435.

Tao, R., Huang, X., Wang, J., Zhang, H., Zhang, Y., et al. (2010). Proposed diagnostic criteria for internet addiction. *Addiction*, 105, 556–564.

Think with Google. website accessed on 13th August 2014 http://think.withgoogle.com/mobileplanet/de/graph/?country=de&category=DETAILS&topic=Q00&stat=Q00_1&wave=2013&age=all&gender=all&chart_type=&active=stat(2013).

Wu, R., Rossos, P., Quan, S., Reeves, S., Lo, V., Wong, B., et al. (2011). An evaluation of the use of smartphones to communicate between clinicians: a mixed-methods study. *J. Med. Internet Res.*, 13, e59.

Yarkoni, T. (2012). Psychoinformatics new horizons at the interface of the psychological and computing sciences. *Curr. Dir. Psychol. Sci.*, 21, 391–397.

Yogesh, S., Abha, S., & Priyanka, S. (2014). Mobile usage and sleep patterns among medical students. *Indian J. Physiol. Pharmacol.*, 58(1), 100–103.