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Controversies in Sleep Medicine: Do We Need More Sleep?

Is Society Sleep Deprived?

One of the conventional wisdoms in sleep medicine is that our modern society is severely sleep deprived, ınd that this chronic state of deprivation has consequences on the person and on society. Examples that are requently cited include catastrophes occurring during the sleep period. Many people want to sleep less, because hey perceive sleep to be a waste of time and not productive. Many other people want to sleep more because hey do not feel quite right. How much should we sleep? As will become apparent in the following two articles, here does exist a controversy that is legitimate and scientifically based. Most of us have seen the experiment ›f nature where for some reason there is no coffee in the morning; the entire office is in a daze. Not until the efinitive study is done to examine this phenomenon rigorously will we truly be able to answer the question bout whether our society is sleep deprived. Until that time, we are stuck with the published data and the :ader can decide whether we are sleep deprived and whether the consequences are severe.

—Meir H. Kryger, Section Editor

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Should We be Taking More Sleep?

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Summary: Reports of reduced daytime sleepiness following extended nighttime sleep in normal, regular sleepers suggest that they (and perhaps much of the general population) are chronically sleep deprived. However, 1) the social and environmental contexts of sleep allow for much intraindividual variation in sleep duration and structure; 2) animal studies show that when there is opportunity for sleep and few incentives to remain awake, sleep occurs for reasons other than in response to a physiological requirement, i.e. sleep satiation may precede actual awakening, 3) accounts of increased sleep duration earlier this century are flawed and 4) because increased sleep onset latency and wake after sleep onset are features of extended sleep, it would be difficult to persuade people to sleep longer for the small benefits to daytime alertness. Laboratory studies show that 1) following extended sleep the improvements in daytime alertness are minor, even by the Multiple Sleep Latency Test (MSLT), and could be achieved equally successfully and with less disruption to habitual daily patterns by taking a short nap; 2) normal subjects extend sleep at night not necessarily because they are chronically sleepy, because there may be no prior MSLT signs of daytime sleepiness; 3) mood effects of extended sleep are confounded by earlier bedtimes; and 4) extended sleep does not necessarily make subjects feel well rested immediately on waking. In sum, most people are not chronically sleep deprived but have the capacity to take more sleep, in the same way that we eat and drink in excess of physiological needs. **Key Words:** Sleep loss—MSLT—Sleepiness—Extra sleep.

re is considerable interest and debate about how sleep we need, whether the "average" 7.5 hours y sleep is enough and whether daytime func- ; can be improved by taking more daily sleep (1–4). Whereas current opinion seems to moving towards "take more sleep and be less sleepy when awake" (5), we argue that 1) on a cost (loss of wakefulness) benefit (improved waking functioning) analysis, sleeping beyond one's "norm" produces, at best, only marginal benefits for the majority of people; 2) the ability to extend one's sleep is not evidence of a need for this extra sleep; 3) the social and environmental contexts of sleep allow for considerable variation in both its

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duration and structure and 4) without there being appreciable improvements in subjective well-being throughout the day, many people are unlikely to be persuaded easily about the benefits of changing their daily sleep/wake patterns in order to take more sleep.

In 1975, Webb and Agnew (6) produced their influential paper, "Are we chronically sleep deprived?", implying that this indeed was the case, and outlining many of the arguments that have since been echoed extensively. The thrust of these arguments falls under the main headings: the ability to take extra sleep both as part of an experimental requirement and spontaneously at home; all of sleep fulfils a physiological need; historical accounts of self-reported increased sleep duration (particularly at the turn of the century); and the inability to terminate sleep spontaneously or feel well rested immediately on waking. Under these headings we shall also produce counter-arguments that are not in keeping with a view of widespread chronic sleep deprivation.

Laboratory studies of extended sleep and subsequent daytime alertness

Interest in this issue began to take shape about 15 years ago, coinciding with advances in the measurement of daytime alertness, in particular the development of the Multiple Sleep Latency Test (MSLT). This device offered an objective and practical approach to measuring the relationship between sleep and daytime functioning, and in particular, provided an opportunity to monitor change following the manipulation of nighttime sleep. Reports of benefits in extending the duration of sleep at night [e.g. 4 nights of sleep extension (1) or 6 nights of sleep extension (3)] helped both to emphasize the disadvantages of insufficient sleep and to secure a role for the MSLT in determining change in daytime sleepiness.

However, in the following summary of the contribution made by experimental studies of change in alertness/sleepiness throughout the day following more sleep at night, it can be seen that the advantages of extending sleep may not be so apparent.

1) For the regular sleeping, healthy, young individual with a relatively low level of daytime sleepiness following a preferred sleep schedule, we can expect an improvement in daily MSLT scores of between about 1 and 4 minutes when the time spent in bed is increased from 8 to 10 hours (1,3,7).

2) The main effect on MSLT trials has been found to occur in the afternoon (7). During morning trials, the likelihood of sleep occurring is relatively low both before and following extended sleep. Roehrs et al. (3) found a worsening of MSLT scores during 1000 hours MSLT trials following the initial nights of extended sleep. In those subjects these investigators (3) termed "alert" (as opposed to "sleepy"), the small (<2 minutes) but significant improvements to MSLT scores only became apparent after 6 nights of extended sleep, and they were confined to afternoon trials. We argue that these "alert" subjects do not represent an extreme or uncommon level of alertness, as Roehrs et al. (3) suggest, because with baseline scores of around 16 minutes, these subjects typify the normal individual. Hence their subsequent, limited improvement to their MSLT scores following extended sleep, is also probably typical.

3) Alternative measures of waking alertness following extended sleep have provided unimpressive and inconsistent results, e.g. whereas Roehrs et al. (3) found sleep extension to improve reaction time (RT) significantly, these effects were small (<10% reduction in RT), and we believe them to be of little behavioral significance or real practical relevance, especially when considering the overall cost to the subject in lost productive wakefulness. It should also be noted that Roehrs et al. (3) observed that this performance testing may have been affected by practice. In our own recent study (7), we also found a very small (12%) but statistically significant improvement to the Wilkinson Auditory Vigilance Test (WAVT) during a 14-day regimen of sleep extension. On the other hand, Taub et al. (8) reported decrements in both WAVT and a complex motor task following 2 nights of extended sleep [total sleep time (TST) = 9.1 hours]. In another study Taub (9) found reduced vigilance performance and increased subjective sleepiness following 1 night of extended sleep.

Although we argue that performance improvements of this magnitude have little established ecological validity, for other investigators they are seen as an indication of a need for extra sleep (1–3). However, it should also be noted that extended sleep studies frequently include individuals without complaints of excessive daytime sleepiness, and with relatively low levels of objectively defined daytime sleepiness. Thus the perceived benefits of taking more sleep might well seem unconvincing to these individuals. For example, we (7) found that to gain about 1 minute of improvement in MSLT score, subjects had to invest an extra 2 hours of their time in bed, of which only approximately 60 minutes was actual sleep.

Apparent ambiguities between MSLT and performance findings in normal healthy subjects are further exemplified by Manni et al. (10), who concluded that MSLT scores obtained from such subjects (young adults) were indicative of a "fairly marked objective drowsiness" despite no additional signs of this using sleep-sensitive performance tasks.

Changes in subjective measures following the opportunity to extend sleep have been reported. Wehr et

al. (11) compared the effects of 28 consecutive "long" nights (14 hours of bed-rest in darkness) with 7 "short" nights (8 hours of bed-rest in darkness). Increased TST and improvements in self-reported vigor and daytime fatigue were viewed by the authors to reflect a preexisting sleep deficit. However, Totterdell et al. (12) found that enhanced mood (cheerfulness, alertness) throughout the day was related to an earlier than normal sleep onset during the previous night, and not to TST. As the advancement of lights out tends to be adopted as a convenient method of extending sleep (1,3,7), the subjective consequences attributed to a night's extended sleep are likely to be confounded by factors other than sleep duration. This was further illustrated by Hawkins and Shaw (13) in a repeated measures study of sleep duration and subjective sleep quality in college students. Differences in sleep duration on weekday nights and at weekends were found to coincide with an improvement in subjective sleep quality during extended sleep on weekends. However, a corresponding reduction in sleep quality was not found when subjects elected to reduce their sleep across the semester as their workloads increased.

"Extra" sleep—a physiological need or a luxury?

The spontaneous lengthening of sleep at weekends has been well documented for both young (6) and older adults (14). Additionally, the ability to extend sleep in the laboratory is commonly observed and interpreted with reference to an underlying sleep debt (1,3,4). It assumes that the occurrence of sleep can be measured as a response to a physiological requirement and is predicted on the basis of an individual's recent sleep history. This popular view is exemplified through the rationale for the MSLT. Carskadon and Dement (15) offered a conceptual divide between two types of sleepiness: physiological sleepiness as an absolute consequence of sleep need dependent on prior sleep behavior, and manifest sleepiness as a context-dependent expression of an underlying state fluctuating according to changes in external and psychological conditions. Thus situational factors such as boredom, anxiety, physical comfort, etc. can influence the manifestation of sleepiness as it is experienced subjectively and by its effects on psychological performance. Unlike self-report techniques or many performance tasks, the MSLT is believed to provide direct access to the underlying level of physiological sleepiness. Factors attributed to manifest sleepiness will not cause physiological sleepiness, nor lead to the initiation of sleep (15). By implication all sleep is considered to be purposeful in terms of satisfying a physiological sleep need.

However, we argue that several areas of research covered by both human and animal studies lend themselves to an alternative explanation for the capacity to take extra sleep, such that in situations where there is every opportunity for sleep, and few incentives to remain awake, sleep can occur for reasons other than in response to a physiological need. For example, laboratory cats spend (16) more time asleep or in a drowsy state following a schedule involving long, uninterrupted periods of isolation and darkness (12 hours dark/12 hours light) than during an alternative schedule of shortened light/dark cycles (79 minutes dark/27 minutes light) for an equivalent period of time. Cats fed more than twice their normal quantity of food showed an increased TST (17), and baboons kept in field conditions had (18) shorter TSTs [more stage 1 and less stages 3, 4 rapid eye movement (REM) sleep] than in laboratory conditions. Ruckebusch (19) reported a 30% increase in TST when ponies previously allowed to graze in an open field were continuously stabled. A similar pattern of increased TST, particularly REM sleep, was found when cows were transferred from an open field to continuous stabling (19). Ruckebusch (19) considered this extra sleep to be in excess of the physiological requirements of the animal, and suggested instead that it represented a "luxury form" of sleep, referred to more recently by Horne (20) as "optional sleep".

From this view, wakefulness, like sleep, is dependent on cues from the immediate physical and social environment. For animals these cues include the need to maintain adequate food supply, shelter and physical security. As Ruckebusch (19) pointed out, the stabled animal is no longer able or required to perform these functions and experiences less involvement with the immediate surroundings. For humans, cues to promote wakefulness are likely to be more complex. Other than a requirement for food and personal safety, most individuals conform to a large number of social activities that operate as powerful social zeitgebers in the organization of individual work, free time and sleep schedules. As for the spontaneous lengthening of sleep, this can be seen to coincide with a loosening of these zeitgebers, e.g. at weekends and holidays. We can perhaps include a tendency to oversleep throughout periods of withdrawal or alienation from social involvement, e.g. during a depressive episode (21,22). From these perspectives, extended sleep observed in self-report studies or more contrived experimental situations, in which there is every opportunity to sleep and few benefits to remaining awake, might be understood in terms of a volitional act rather than a physiological requirement.

As Webb and Agnew (6) indicated, given the opportunity for unlimited food, many people will eat more than they need, and the same may apply to sleep. Aserinsky (23,24) demonstrated this latter capacity throughout long periods of enforced bed-rest in his

subjects, such that 20 out of 30 hours of bed-rest (23) and 32 out of 54 hours of bed-rest were spent asleep (24). Gagnon et al. (25) reported significant increases in TST throughout 15 hours of enforced bed-rest in darkness following a normal bedtime, and under both novel and habituated phase-delay conditions. Campbell (26) noted that subjects slept for almost half (28 hours) of a 60-hour bed-rest period. Wehr et al. (11) reported increased TST throughout 28 "long" night (14 hours of bed-rest in darkness) in comparison with "short" nights (8 hour baseline nights). Under all of these circumstances individuals would be highly motivated to sleep in order to avoid lengthy periods of boredom, which might explain why Roehrs et al. (3) and Harrison and Horne (7) found that subjects were able to sleep significantly longer throughout 6 and 14 nights, respectively, despite relatively low baseline measures of daytime sleepiness determined by the MSLT (i.e. about 16 minutes).

Historical accounts of reductions in self-reported sleep duration

Webb and Agnew (6) reported a reduction of about 1.5 hours in the average sleep duration of children aged 8 to 17 years between the periods of 1910 to 1911 and 1963, and they asked whether this is symptomatic of a relatively recent increased pressure to economize on the time allotted to sleep. It is conceivable that such a change has occurred given the rapid development of social, economic and technological advances between these periods. However, inconsistencies between the surveys suggest that this is a comparison based largely on errors of protocol and sampling [over 2,000 respondents in the 1910–1911 survey as opposed to 311 in the 1963 survey detailed by Webb (27)]. Ironically, Terman and Hocking (28), the authors of the original study, went to some lengths to explain why, at that time, they had found an actual increase in average sleep length (described by them as a "striking excess of sleep") compared with other contemporary studies originating in Germany and the U.K. Furthermore, a survey (29) of over 5,000 Japanese children during the spring of 1923 reported an average of 1 hour less sleep compared to children of the same age group in the Terman and Hocking study (28). When Weissbluth et al. (30) compared the sleep of 8- to 17-year-old children studied throughout 1980 in the U.S.A. with those in the 1910–1911 survey, no differences in average TSTs were found. These apparent inconsistencies between studies highlight the difficulties inherent in such approaches and undermine Webb and Agnew's (6) implication that a genuine reduction in TST over time has occurred.

Trends in TST over the long term between different subjects groups are likely to be confounded by changes in subject compliance and experimental protocol [especially when relying on subjective estimates that are liable to be more inaccurate with poorer sleepers (31)]; mood (32); individual differences in economic status, home environment, etc. (28,33) and seasonal, climatic and geographical differences (34).

More recently, apparent changes in the subjective reports of sleep habits among college students have been interpreted to suggest that this group is particularly at risk from peer and work-related pressures to take less sleep than necessary. For example, Hicks et al. (35) reported a 30-minute reduction in the average self-reported TST of students at San Jose University between the years 1978 and 1988. However, such changes may be linked with transient changes in workload (13) and season and time spent at college (36,37). For example, Carskadon and Davis (36) found a reduction in self-reported TSTs of about 20 minutes during the first term of college, compared with TSTs 6 months prior to entering college. Although this period coincides with a major life change towards independence, the effect on sleep is short lived, because follow-up surveys for a further 2 years at college suggest some seasonal change (longer TSTs during the fall), with a gradual overall increase in TST by the third year of college similar to pre-college entry levels (37). Thus, short-term factors leading to change in sleep habits (that tend not to be controlled for) are likely to undermine claims of a progressive reduction in TST over recent decades.

There have also been several recent large-scale surveys directed towards sleeping habits. A number of interesting findings relating to the points raised earlier (6) emerge. Lavie (14) found spontaneous extensions of sleep duration at weekends, with over half the respondents choosing to wake unaided. Billiard et al. (38) found that daytime sleep episodes, as an indication of daytime sleepiness, were more likely to occur in habitual short and long sleepers rather than in the 7- to 9-hour sleeper. Concerning long-term adverse health effects, sleeping longer than the average 7–9 hours has been associated with increased mortality rates, as shown by a 9-year follow-up of 4,713 Alameda County residents (39) and a 6-year follow-up of 1 million respondents to the American Cancer Society survey (40).

Failure to end sleep spontaneously or feel well-rested on waking

Webb and Agnew (6) suggested that the failure to end sleep spontaneously might result in the premature termination of sleep prior to sleep satiation. They referred to a 1937 study in which only 30% of subjects awakened spontaneously in the morning as a further

indication of an incomplete fulfillment of a sleep requirement. Presumably the remainder of subjects relied on alarm clocks or the intervention of co-habitants for early morning awakening. However, as contemporary societies rely on the coordination of activity, punctuality is a highly valued attribute. We have just argued that the satiation of sleep may precede the end of sleep, and it is not surprising that without complete reliability in the regularity of sleep offset mechanisms, most people prefer to not leave waking up to chance.

Bell (41) tested the accuracy with which individuals spontaneously awaken at a chosen time. For well-rested, healthy, adult subjects, accuracy to within 15 minutes of a target time was 53% [a similar finding was reported by Hawkins (42)]. Bell (41) also reported that accuracy increased with general overall sleep disturbance, i.e. increased awakening. Thus, for the individual prone to frequent intermittent awakenings during the latter part of the night, the ability to wake up at a preselected time is more likely to be due to the increased number of involuntary awakenings coinciding with a target time, rather than to judgement.

There is no scientific evidence to suggest that feeling well-rested immediately on waking is a necessary or even likely indication of sleep satiation. For example, Naitoh et al. (43) describe a period of sleep inertia following the termination of sleep as part of the awakening process, which lasts an average of 5 minutes. Åkerstedt et al. (44) investigated intraindividual differences in subjective measures of sleep quality following sleep episodes that were irregular in length and occurred at different phases of the circadian cycle. The timing of the end of sleep in relation to circadian phase was found to be an important predictor of subjective measures of sleep quality, feeling refreshed and ease of awakening. In addition, whereas subjects were more likely to feel refreshed on waking following highly efficient sleep, the ease of awakening was found to be improved with reduced sleep efficiency, and it was also negatively correlated with TST. Åkerstedt et al. (44) suggest that reduced sleep inertia following poorer, or more superficial sleep, might account for this.

Hence, there is no reason to assume that the ability to wake and feel refreshed in an instant will improve with increased prior sleep. Conversely, the process of going from wake to sleep at bedtime is not instantaneous. In fact, as the ability to switch rapidly from a waking to a sleep state might be considered symptomatic of an underlying sleep disorder (45), the alternative might be seen to be, at least, unusual.

There have also been reports of a worsening of the morning transition between sleep and wake following extended sleep, exemplified by the "worn-out syndrome", which is a protracted period of thick-headedness and lethargy (46).

Rapid sleep onset and high sleep efficiency—signs of sleep debt?

Contemporary sleep patterns tend to be artificially constrained and context dependent. When normal restrictions on sleep were removed, Campbell (26) found that subjects adopted a polyphasic sleep pattern, i.e. frequent, shortened episodes of sleep throughout a 60-hour bed-rest period. Wehr et al. (11) examined the proposition that modern lifestyles, especially the advent of artificial lighting, mask natural sleep patterns by separating the 24-hour period into an extended day and a shortened night. The opportunity for sleep is thus believed to be artificially compressed into a single 8-hour period. Throughout 28 consecutive "long" nights of 14-hour bed-rest in darkness there was (11) an increased sleep period time characterized by more discrete, yet shortened sleep episodes, increased amounts of stages 1, 2 and REM sleep and an increase in wake after sleep onset (WASO). However, the question remains whether the imposition of a socially determined sleep/wake pattern resulting in consolidated sleep throughout the night is incongruous with a physiological sleep need.

Some researchers have assumed a negative association between sleep efficiency and sleep satiation, whereby a shortfall in sleep leads to a higher sleep efficiency. That is, the natural state of sleep is for a longer sleep onset latency (SOL), more WASO and less sleep efficiency (4,11,47,48). Hence the converse, short SOL and less WASO, are signs of greater sleep need. An association between high sleep efficiency throughout the night and a high level of sleepiness on MSLT trials throughout the following day in young, healthy adults has been presented as further evidence of repeated failures to satisfy a sleep need (47). However, if we consider individual differences in SOL during both the nocturnal period and throughout MSLT trials to be, at least partially, dependent on the efficiency of sleep onset mechanisms, it is not surprising to find that those subjects who experienced the most difficulty initiating sleep at night were those least likely to fall asleep quickly throughout MSLT trials during the following day.

In their study, Totterdell et al. (12) found a shorter SOL and less awakenings throughout the night (but not TST) to be associated with improved subjective sleep quality and enhanced mood throughout the following day. Åkerstedt et al. (44) also found subjective sleep quality to be improved with increased sleep efficiency. We argue that the enhancement of sleep efficiency represents for most people a valued aspect of sleep behavior. Furthermore, because increased SOL and WASO are common features of extended sleep, it would be difficult to persuade most individuals of the benefits of sleeping longer.

Conclusions

An increasing concern that many people may not be getting enough sleep has led to a number of sleep researchers calling for increased efforts towards raising popular and scientific awareness of risks associated with this problem (5). A recent report (49) by the National Commission on Sleep Disorders Research referred to the self-imposed restriction of sleep below acceptable limits and called for a "radical change in the way society deals with sleep".

Various major accidents have been reportedly attributed to sleep-related human error (50). Researchers have also advocated a causal relationship between inadequate nighttime sleep and increased sleep-related traffic accidents (5), increased daytime sleepiness (1,2), impaired performance (3), and mood (11) throughout the day. These findings imply that many individuals forego essential sleep to maximize time spent in waking activity, and at a cost to both their personal safety and their potential for self-fulfillment. But rather than sleep length per se being the underlying cause, the more direct involvement of total sleep loss and circadian influences on arousal/sleepiness are the most important features of many incidences in which individuals are overwhelmed by the urge to sleep. This is clearly evident in the temporal distribution of traffic accidents across the 24-hour period, in which the prime period of increased risk is early morning (50–52), when the victims have had no recent sleep. That is, they were vulnerable because of the inappropriate timing of sleep. It does not suggest that they should be taking more than their usual 7.5-hours of daily sleep. Extended nighttime sleep has yet to be shown to improve alertness during a subsequent night of no sleep. On the other hand, the afternoon dip in alertness might be partially avoided after taking extended nighttime sleep (3,7), and the relevance of this to performance during the afternoon in real-life situations requires further investigation.

However, we would argue that, as the most promising positive aspect of extending sleep at night, improved alertness during the afternoon can be achieved equally successfully by other methods, and with less disruption to habitual daily patterns. For those individuals particularly prone to a period of reduced alertness during the afternoon, an effective solution would be to take a short nap (15 minutes) at a suitable point during the day. Following a night of restricted (4-hours) sleep, Gillberg et al. (53) found a short nap to be effective in maintaining performance on a vigilance task throughout both morning and afternoon trials. Naitoh (54) concluded that a nap as short as 4 minutes (and no longer than 20 minutes) is sufficient to maintain performance. In our view, this option provides a more convenient alternative to the effort required to take more sleep at night [our subjects (7) spent an extra 2 hours in bed to achieve 1 hour of extra sleep] in that a short nap can be easily and discretely incorporated into an individual's existing work schedules, e.g. during a working break.

Webb and Agnew (6) suggested that people have experienced a relatively recent change in attitude towards dedicating time to sleep at night. For Wehr et al. (11) it is the advent of artificial lighting that has proved most influential in these respects. Social impositions may have also had an impact because withdrawal from social influence leads to dramatic modifications to sleep patterns (11,26). Indeed, as we also argue, the duration and structure of sleep is context dependent, influenced by internal and external sources such as the prevailing social, environmental, physiological and psychological factors.

Webb and Agnew (6) asked whether, given the vicissitudes of modern lifestyles, sleep has fallen below the levels of individual necessity. An experimental remedy in the form of extended sleep has shown consistently that the marginal benefits are out of proportion with the actual costs to the individuals in terms of reduced active wakefulness and deterioration in sleep efficiency [e.g. 2 hours more time in bed = 1 hour more sleep = worse sleep efficiency = small improvement in MSLT (7)]. Thus, the real-life significance of extended sleep needs to be put more clearly by proponents of the "take more sleep" view.

We have also focused on a number of observations that run counterintuitive to a view of widespread chronic sleep deprivation. Studies of extended sleep have reported benefits to MSLT scores using subjects reporting to be free from daytime sleepiness, who do not nap during the day and are regular, healthy sleepers (1,2,7). Furthermore, MSLTs in subjects tested at baseline show low levels of daytime sleepiness [subjects did not sleep during 50% of baseline MSLT trials (1)]. Even without obvious signs of sleepiness during the day, subjects are still able to extend their sleep at night, and this situation can be maintained over the long term (7,11), suggesting that this extra sleep is gained for reasons other than a deficit of sleep.

The feasibility of extending sleep over the long term is questionable because the incentives are limited and studies have failed to provide consistent evidence of improvements in subjective well-being or performance ability. Thus we argue that most people are not chronically sleep deprived and therefore do not need to take more sleep than their current "norm". The contrary position still lacks substantive, unequivocal and supportive data—hence the onus remains on its proponents to confirm it.

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