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Too tired to vote: A multi-national comparison of election turnout with sleep preferences and behaviors

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ABSTRACT

Receiving a healthy amount of sleep is essential to one's quality of life. Both sleep-wake timing preferences (chronotype) and sleep duration are implicated in health, academic achievement, and workplace performance. This study complements the existing sleep–politics literature by examining the associations between sleep duration, chronotype, and turnout with a representative cross-national survey dataset from nine national contexts. Our analyses demonstrate that greater sleep duration is non-linearly related to higher turnout; those who sleep too little or too much are less likely to vote. The results also show that morning chronotype is associated with higher turnout, but controlling for religiosity attenuates this relationship. We argue that healthy sleep duration and chronotype lay at the intersection of the socioeconomic and psychological resources necessary to participate in elections.

1. Introduction

Conventional explanations for political participation focus on resources (Brady et al., 1995), identity (Miller et al., 1981), values and ideology (Radcliff, 1994), and social networks (Lake and Huckfeldt, 1998), with recent work adding a focus on indirect influences like implicit cognition (Drake et al., 2015), personality (Gerber et al., 2011a, 2011b), and genetic predispositions (Klemmensen et al., 2012). We argue that access to sleep and sleep-wake timing preferences (chronotype) lay at the intersection of the socioeconomic and psychological resources necessary to participate in politics.

Sleep deficits have broader social implications such as decreased vigilance and higher accident rates (Dinges et al., 1997), lower levels of empathy (Killgore et al., 2008), risky decision making (Ferrara et al., 2015), less prosocial behaviors (Dickinson and McElroy, 2017), and weakening inter-personal communication skills (Holding et al., 2019). Eveningness-preference (late to bed, late to rise) also interacts with morning-oriented social norms (Wittmann et al., 2006) to impair physical and mental health, sleep quality, and workplace performance (Fabbian et al., 2016). Prior research has found a positive relationship between morning chronotype (early to bed, early to rise) and conservatism in the United States (U.S.) and the United Kingdom (UK) (Ksiazkiewicz, 2020) as well as in the context of a larger international sample (e.g., Canada, the UK, the U.S., and also fifty-four other countries with smaller numbers) (Ksiazkiewicz, 2021), and shorter sleep duration and lower voter turnout in the U.S. (Holbein et al., 2019; Schafer and Holbein, 2019; Urbatsch, 2014). Considering sleep's centrality in our personal and social lives and the potential importance of social institutions in moderating those influences, we explore how sleep duration and chronotype are related to political participation, particularly election turnout, across national contexts.

Using nationally representative data collected in nine countries (Finland, Greece, Ireland, Mexico, the Netherlands, New Zealand, the Philippines, Russia, and South Korea), we integrate sleep research into the comparative analysis of election turnout. Whereas prior work in the U.S. suggested that inadequate sleep could lower turnout (Holbein et al., 2019), we find that the effect of sleep duration is non-linear in seven countries (e.g., Finland, Greece, Ireland, Mexico, the Netherlands, the Philippines, and South Korea). In fact, excessively sleepy participants are more likely than those with sleep deficiency to not turn out, implying that immoderate sleep debt and abundance may differentially harm participatory potential. We also observe that morning chronotype is associated with higher turnout in all nine countries, but this effect is confounded by religious observance – a civic participation covariate influencing both sleep-wake timing preference and voting. We test the robustness of our findings by accounting for several factors such as

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day-season grouping of sleep-wake measures, religious denominations, latitude, longitude, and mean temperature of the residential region and the season at time of election, differences in the democratic quality of political institutions, and time since the last election to account for plausible turnout misreporting because of memory failures. We conclude by laying out a sleep – political participation research agenda.

We believe our study's theoretical perspective, empirical design, and findings can have significant implications for understanding democratic political participation. In principle, citizens should have an equal chance of participating in politics, at least by voting, and the state is expected to reduce undue burdens, for example, by introducing new tools like e-voting and postal voting for those who are unable to reach the ballot boxes due to disability and health-related problems (Petitpas et al., 2021). Nevertheless, alleviating the physical inaccessibility of the polling booth does not ensure equality of opportunity in turnout. For instance, resource inequalities are known to play an important role in access to the ballot box (Brady et al., 1995). Despite this, sleep's omission from models of turnout means that nearly all past turnout research is premised on the unstated assumption that healthy sleep in inconsequential for turnout. Consequently, past research has ignored the heterogeneity in access to healthy sleep in the mass public and sleep's vital role as a resource for political participation, even though sleep is essential for survival and cognitive and physical performance in many other domains of life.

2. Theory

We argue that sleep should be considered a political resource alongside time, skills, and money (Verba et al., 1978). Unlike political knowledge and wealth, sleep cannot be banked in advance and accumulated over time (although the health consequences of atypical sleep habits can accumulate over time and, in return, could dampen participatory potential) (Burden et al., 2017). Sleep is more similar to time, insofar as it is (or should be) replenished daily. Where it differs is that unlike time, where everyone receives the same amount each day, access to sleep is not equal across individuals due to personal circumstances and structural inequalities. For instance, not every individual has synchronicity between their individual sleep-wake cycle and the solar clock (day-night cycle) or the social clock (societal expectations around time use), partly owing to the variation in human physiology (e.g., age, genetics, and sex) and partly because of the differences in the environment (e.g., artificial lights at night, geographical and seasonal effects on exposure to natural light at night, parenting practices, and working hours) (Kalmbach et al., 2017). This means that those citizens not getting enough sleep (or getting too much sleep) and/or not being able to adjust their biological clock to the social clock will be less likely to be energized by the mobilization of the leaders, movements, and parties to turn out to vote, will be more likely to see the act of turnout as costly, and will be less likely to be cognitively involved and interested in politics, which limits their ability to to sort their individual preferences along ideological-partisan lines and then to influence public life by voting accordingly (cf. Smets and van Ham, 2013).

2.1. Sleep duration and voting

Previous research on how inadequate sleep may affect civic participation (Holbein et al., 2019) lays out several direct and indirect theoretical pathways. Firstly, those citizens lacking sleep may try to conserve their limited energy for more personally beneficial activities than time-costly civic participation, like turnout. Second, insufficient sleep negatively affects citizens' mental and physical health and thereby might reduce prosocial behaviors such as voting because of impaired cognitive functioning and fatigue. In addition to these theoretical expectations, we believe that unhealthy sleep patterns may reduce electoral participation for a variety of other direct and indirect reasons. For instance, sleep loss, which weakens temporal memory (Harrison and Horne, 2000), may reduce voter turnout by causing citizens to forget election day or poll opening and closing times, vote center location, and/or voter identification documents they must bring with them before voting. Furthermore, even if those sleep-deprived citizens would want to vote, insufficient sleep and the resultant vigilance decrement might indirectly lower turnout because of hospitalizations by car accidents and household and work-related injuries (Uehli et al., 2014). Additionally, though it may be valid for half of the population only, sleep deprivation may cause adult males to avoid dominance competitions such as elections (Stanton et al., 2009) by lowering testosterone levels (O'Byrne et al., 2021).

Accordingly, shorter sleep duration has been empirically linked with lower voter turnout. This alignment was found using observational cross-sectional survey analysis in the U.S. and Germany, geographical regression discontinuity application in the U.S., and experimental manipulation of short-term sleep in the U.S. (Holbein et al., 2019; Schafer and Holbein, 2019), and correlational analyses on state-level autumnal clock shifts before the U.S. general elections (Urbatsch, 2014). Considering this evidence, we pre-registered the hypothesis that greater sleep duration may be associated with higher turnout across a wider range of national contexts (but see section 5.3 for the additional theoretical argument and analysis that substantiates a curvilinear relationship between sleep duration and turnout that we did not anticipate *a priori*).

H1. Greater sleep duration and higher turnout are positively related.

2.2. Chronotype and voting

Prior research has found a positive relationship between morning chronotype and conservatism in several samples in the U.S. and the UK (Ksiazkiewicz, 2020), as well as a positive association of conservatism with both self-perception of being a morning type and having favorable attitudes toward morning compared to night in a larger multi-national convenience sample (Ksiazkiewicz, 2021). The relationship between chronotype and political participation remains undertheorized.

Following the resource model of political participation (Verba et al., 1995) and past sleep duration and political participation research (Holbein et al., 2019; Schafer and Holbein, 2019; Urbatsch, 2014), it may be reasonable to consider adequate sleep as a type of resource that is a necessary condition to take part in politics (see section 2.1). Past research suggests that evening types receive less sleep than morning types because of professional pressures to wake up earlier than they would otherwise prefer to (Giannotti et al., 2002). This is because the biological clock of evening types, resulting in sleep-wake preference of late to bed and late to rise, is not in sync with the social clock (e.g., morningness-oriented 9-to-5 business and school hours). Evening types' sleep habits, therefore, deviate from the social clock and lead to lower amounts of sleep on weekdays compared to morning types (Roepke and Duffy, 2010). Combined with the observation that evening types try to make up this sleep loss on weekends, this phenomenon is called social jet lag (Wittmann et al., 2006). Given that sleep loss is linked to lower turnout and that morning people are less likely to get inadequate sleep, we might expect morningness to be connected to higher turnout. Moreover, since morningness has a positive relationship with the Big Five personality trait Conscientiousness, which explains individuals' propensity for norm-compliance and rule-abidance (Lipnevich et al., 2017), morning types might be more likely to see voting as a civic duty to be complied with. Similarly, morningness' positive association with mental and physical health (Partonen, 2015) and academic achievement and workplace performance (Tonetti et al., 2015) might make morning types more psychologically and socio-economically well-equipped and motivated to influence the governance of their polities by voting. Thus, based on these previous works, we hypothesize that morningness may be associated with higher turnout.

H2. Morningness and higher turnout are positively related.

2.3. Light pollution as the confounder between sleep and political participation

We entertain the possibility that sleep duration and preferences and voting are all influenced by an underlying confounding factor. Natural and artificial lights at night affect the human circadian clock, regulating the body's perception of day and night (Boivin et al., 1996). As such, light pollution in cities has been shown to disrupt the synchronicity between the sleep-wake and day-night cycles (Wright et al., 2013). As a result, city dwellers tend to sleep later and wake up later, with plausibly shorter sleep duration (Pilz et al., 2018). Professional pressures, particularly in agricultural and livestock work, may also cause people to rise earlier in rural populations, with higher levels of sleep (Carvalho et al., 2014). At the same time, rural residents are more likely to vote because of the social pressures of being seen voting in small and connected communities (Funk, 2010), possibly lower information costs of better knowing the candidates and their policy proposals in rural areas (Geys, 2006), the advantage of frequently using private transportation in rural areas on election days with bad weather (Garcia-Rodriguez and Redmond, 2020), and the relative lack of leisure time (due to nontraditional working shifts unlike 9-to-5 weekday schedule) potentially preventing last-minute entertainment distractions from civic affairs (Potoski and Urbatsch, 2017). Thus, we think that urban-rural area of residence (as a proxy for light pollution) may confound the relationship between sleep duration and preferences and voting.

H3. The relationship between greater sleep duration and higher turnout is attenuated by controlling for the residential area's urbanization.

H4. The relationship between morningness and higher turnout is attenuated by controlling for the residential area's urbanization.

3. Methods

We use data from two different original sources. The first is a multinational survey study, the International Social Survey Programme (ISSP) 2007 Leisure Time and Sports module (ISSP Research Group, 2009). This ISSP module surveys the frequency of several leisure time activities and the leading causes for practicing and not practicing them in 34 countries. In the module, we only use the subset of the broader international sample with the available sleep-related variables: Finland (2007, $N = 1265$), Ireland (2008, $N = 1975$), Mexico (2008, $N = 1527$), the Netherlands (2008, $N = 859$), New Zealand (2007, $N = 948$), the Philippines (2008, $N = 1092$), Russia (2007, $N = 1811$), and South Korea (2007, $N = 1329$). The second is a post-election survey study in Greece (2020, $N = 750$) conducted for the Comparative Study of Electoral Systems (CSES) from December 2019 to February 2020. Most of the Greek CSES data (over 93%) were collected after the indirect presidential election held by the Hellenic Parliament on January 22, 2020, and the survey field ended before the first confirmed case of COVID-19 in Greece on February 26, 2020.[1]

3.1. Dependent variable

Our dependent variable is *Turnout*. We coded those respondents who voted in the last elections as 1 and those who did not vote as 0. This measure is based on direct self-reports of the participants. The elections in consideration per country are as follows: Finland (March 18, 2007, Parliamentary Elections), Greece (July 7, 2019, General Elections), Ireland (May 24, 2007, General Elections), Mexico (July 2, 2006, Presidential Elections), the Netherlands (March 7, 2006, Local Council Elections), New Zealand (September 7, 2005, General Elections), the Philippines (May 10, 2004, General Elections), Russia (March 14, 2004, Presidential Elections), and South Korea (May 31, 2006, Local Elections).

3.2. Independent variables

Our main independent variables of interest are *Sleep Duration* and *Chronotype* (mid-point timing of sleep). We employ the variables measuring the respondents' times of getting up and going to bed, ranging between 0 (00:00 o'clock) and 2359 (23:59 o'clock). While the ISSP module inquires about sleep and wake times the day before the interview, the Greek CSES data asks sleep and wake times when considering free days (e.g., a normal day without work, school, or any events to attend). The sleep measures from the ISSP module are suboptimal because the sleep variables are from the previous day rather than on free days, which is the conventional approach (see Research Note 1 in the Online Appendix). However, for two reasons, we think this measurement discrepancy might not have a bearing on our findings' reliability. Firstly, results linking political characteristics to chronotype are robust to different measurement approaches (see Tables S1 and S20 in Ksiazkiewicz, 2020). Second, our multivariate findings from Greece using the conventional measure do not differ from the general trends in countries surveyed by the ISSP.

From the available sleep measures, then, we create four variables: *Wake Hour* (0–23), *Wake Minute* (0–59), *Sleep Hour* (0–23), and *Sleep Minute* (0–59). Later, we develop the final constructs: *Wake Timing* (*Wake Hour* + *Wake Minute*/60) and *Sleep Timing* (*Sleep Hour* + *Sleep Minute*/60). We, then, calculate *Sleep Duration* by *Wake Timing* – *Sleep Timing*. If *Wake Timing* is smaller than *Sleep Timing* (i.e., because *Sleep Timing* is before midnight and *Wake Timing* is after midnight), we replace *Sleep Duration* values with 24 – *Sleep Timing* + *Wake Timing*. This gives us the number of hours slept.

Next, we calculate *Chronotype* by *Wake Timing* – *Sleep Duration*/2. If the resultant *Chronotype* value is smaller than 0 (indicating a sleep midpoint before midnight), we add 24 to the mid-point timing of sleep values (to return it to 24h clock time). Later, we center the resulting *Chronotype* values to 20 (e.g., *Chronotype* – 20 [20:00, an hour between the latest evening chronotype and the earliest morning type in the dataset]). Finally, we multiply the final mid-point timing of sleep numbers by −1 such that smaller values indicate evening chronotype (night owl) and higher values indicate morning chronotype (morning lark).

In the dataset, as per Ksiazkiewicz (2020), we only use the data from survey participants whose (i) time of sleeping was after 19:00 (inclusive) or before 06:00 (inclusive), (ii) time of waking up was after 04:00 (inclusive) and before 15:00 (inclusive), and (iii) *Sleep Duration* was in-between two and 18 h. Respondents who do not satisfy these exclusion criteria are assumed to have atypical sleep duration and preferences

[1] Even though the ISSP data was collected before our analyses, we pre-registered two of our original hypotheses about chronotype-turnout links (H_2 and H_4), which are not covered by the scholarship, at the Open Science Framework (OSF) before collecting the Greek survey data (https://osf.io/2y4ut). Even though we did not pre-register our expectation of seeing a positive relationship between sleep duration and turnout (H_1), prior theoretical discussion and empirical evidence give us no reason to think otherwise about this link. The confounding role of urbanization in the relationship between sleep duration and voting (H_3) is a natural extension of the pre-registered H_4 because our theoretical reasoning to predict a positive relationship between morningness and higher turnout (H_4) partly benefits from the theoretical channels on sleep duration – voting alignment (H_1).

and are removed from the data.[2]

3.3. Control variables

We have four types of control variables that we can account for with the available data. The first type is the geographical control, *Urban-Rural Area of Residence*, the main covariate of theoretical interest. *Urban-Rural Area of Residence* (H_3 and H_4) is on a 1–4 scale ranging from 1 (farm or home in the country or country, village) to 2 (town or small city) to 3 (suburb, outskirt of a big city) to 4 (urban, a big city) (see Research Note 2 in the Online Appendices).

The second type consists of biological controls, *Age* and *Sex*. Age is a ratio variable for the survey takers 18 years old or above. *Sex* is a binary variable (female = 0, male = 1).

The third type involves socioeconomic controls, *Education* and *Income*. The interval *Education* ranges from 0 (no formal qualification) to 1 (lowest formal qualification) to 2 (above lowest qualification) to 3 (higher secondary completed) to 4 (above higher secondary level) to 5 (university degree completed) (see Research Note 3 in the Online Appendices). The interval *Income* is on a 5-point scale between 1 (lowest) to 5 (highest) (see Research Note 4 in the Online Appendices).

The fourth type comprises political controls, *Level of Interest in Politics*, *Left-Right Ideological Placement*, and *Religious Attendance*. The interval *Level of Interest in Politics* ranges from 1 (not at all interested) to 2 (not very interested) to 3 (fairly interested) to 4 (very interested). The interval *Left-Right Ideological Placement* is on a 1–5 scale; 1 stood for "far-left," 2 for "left, center-left," 3 for "center, liberal," 4 for "right, conservative," and 5 for "far-right" (see Research Note 5 in the Online Appendices). The interval *Religious Attendance* is on a 1–6 scale; 1 stood for "never," 2 for "once a year or less frequently than once a year," 3 for "several times a year," 4 for "once a month," 5 for "2 or 3 times a month," and 6 for "several times a week, once a week, or every day" (see Research Note 6 in the Online Appendices).

We want to include *Religious Attendance*, a proxy of social conservatism potentially correlating with left-right ideology, in our models for two reasons. Firstly, we planned to have two political controls only, *Level of Interest in Politics* and *Left-Right Ideological Placement*. However, partly due to greater degrees of non-response and partly due to the necessity to use a mixture of self-placement and expert rating in ideological positioning in the ISSP module, we wanted to test our models with a behavioral correlate of ideology with fewer missing responses. Hence, we have two sets of models with full controls, one with all covariates plus *Left-Right Ideological Placement* and one with all covariates plus *Religious Attendance*. Secondly, *Religious Attendance* itself can be a sole civic participation covariate (Gerber et al., 2016). Attendance to religious services (and subscription to conservative morality) (Zielińska et al., 2021) may correlate with morningness (and also greater sleep duration) as well as civic involvement (Polson, 2016) because of the religious services' regular practices adjusting the biological clocks to social clocks and religious participation's potential of increasing community and duty orientation and volunteerism. All in all, religion can theoretically be expected to be a confounding factor given the direct and indirect theoretical pathways between morningness and religious observance, such as the positive relationship between religiosity and conservatism (Jost et al., 2014), morningness and conservatism (Ksiazkiewicz, 2020, 2021), morningness and the two motivational types of values (conservation and self-transcendence) positively correlating with religiosity (Vollmer and Randler, 2012), and morningness and the personality trait Conscientiousness positively related to norm-compliance and conservatism (Gerber et al., 2011a, 2011b).

Table 1 below summarizes the descriptive statistics.

3.4. Analytical strategy

To model turnout behavior, we run multilevel logistic regressions with random intercepts and random *Sleep Duration* and *Chronotype* slopes varying across the election types (e.g., general v. local elections) nested into surveyed countries.[3] To converge this complex non-linear multilevel model, we use the Adaptive Gauss-Hermite Quadrature with nAGQ = 0 (see Stegmann et al., 2018, p. 162). To reduce over-correlation among the control variables with fixed slopes (Paccagnella, 2006), we subtract grand means from all non-dichotomous (interval and ratio) covariates and divide them by two standard deviations. The dichotomous covariates are only grand mean-centered. We subtract group means from the random slope variables (*Sleep Duration* and *Chronotype*) and divide the resulting values by two standard deviations. Hence, regression coefficients are comparable across models.

From our multilevel logistic regression estimations, we can obtain three parameters: the fixed-effects (e.g., the constant effect of a variable across individuals), the random-effects (e.g., the difference between the fixed-effect value and the value predicted for a country), and the predicted effects (e.g., the sum of fixed- and random-effects estimates for a country). We look at the last parameter, the predicted effects, to test our expectations.

4. Results

4.1. Multivariate results

The full regression models with the fixed-effects, the predicted effects, and the random-effects are in Tables 1–3 in the Online Appendix. The predicted effects are summarized in Fig. 1. In Model 1 with no covariates, voting is meaningfully negatively associated with greater duration of sleep in all nine national contexts and significantly positively related to higher morningness in all countries except the Netherlands (marginally) and Russia (insignificantly). While the direction of the relationship fits our expectation for the alignment between *Chronotype* and *Turnout* (H_2), the direction of the correlation between *Sleep Duration* and *Turnout* contradicts our prediction (H_1).

Model 2 controls for *Urban-Rural Area of Residence*. Urbanization does not weaken the association between *Sleep Duration* and *Turnout* in any countries (H_3) and does not attenuate the relationship between the mid-point timing of sleep and voting (H_4) in countries with significant bivariate associations.

Comparing Model 3 and Model 4 with full controls (with either ideology or religiosity) shows that ideological orientation confounds the unexpected negative association between greater sleep and higher turnout in the Netherlands and Russia (H_1). Likewise, in all countries except South Korea, religiosity confounds the expected positive link between greater morningness and higher turnout (H_2).

[2] The initial sample size, the final sample size without abnormal sleep patterns and missing sleep measures, and the total number (and percentage) of survey takers dropped from the data due to our exclusion criteria per surveyed country are as follows: 1,346, 1,265, and 81 (6.02%) in Finland (2007); 756 (the original sample size was 771 in which 7 respondents who were under the age of 18 and 8 participants who had missing age information were dropped from the outset), 750, and 3 (0.40%) in Greece (2020); 2,045, 1,975, and 70 (3.42%) in Ireland (2008); 1,558, 1,527, and 31 (1.99%) in Mexico (2008); 892, 859, and 24 (2.69%) in the Netherlands (2008); 972, 948, and 20 (2.06%) in New Zealand (2007); 1,200, 1,092, and 102 (8.50%) in the Philippines (2008); 2,005, 1,811, and 194 (9.68%) in Russia (2007, $N = 1811$); and 1,431, 1,329, and 97 (6.78%) in South Korea (2007).

[3] In our model specification, next to the main country-related differences in turnout, we want to incorporate election type specific dissimilarities as expected by the second-order election (SOE) model (Lefevere and Van Aelst, 2014).

Table 1
Descriptive statistics.

	Finland (*N* = 1265)	Greece (N = 750)	Ireland (*N* = 1975)	Mexico (*N* = 1527)	the Netherlands (*N* = 859)	New Zealand (*N* = 948)	the Philippines (*N* = 1092)	Russia (*N* = 1811)	South Korea (N = 1329)	Overall (*N* = 11,556)
Turnout: Yes (Base: No)										
Mean (SD) [Missing %]	0.83 (0.38) [7.2%]	0.90 (0.30) [0.8%]	0.72 (0.45) [0%]	0.73 (0.45) [4.6%]	0.91 (0.29) [2%]	0.92 (0.27) [9%]	0.82 (0.39) [0.4%]	0.97 (0.17) [8.4%]	0.68 (0.47) [3.9%]	0.82 (0.39) [4.1%]
Sleep Duration										
Mean (SD) [Missing %]	8.2 (1.5) [0%]	7.9 (1.3) [0%]	8.4 (1.6) [0%]	8.0 (1.8) [0%]	8.3 (1.6) [0%]	8.6 (1.5) [0%]	8.3 (1.9) [0%]	7.9 (1.8) [0%]	6.9 (1.7) [0%]	8.0 (1.7) [0%]
Chronotype										
Mean (SD) [Missing %]	−7.2 (1.2) [0%]	−8.5 (1.4) [0%]	−7.8 (1.1) [0%]	−7.0 (1.2) [0%]	−7.6 (1.1) [0%]	−7.0 (1.0) [0%]	−6.0 (1.4) [0%]	−7.4 (1.2) [0%]	−7.5 (1.5) [0%]	−7.3 (1.4) [0%]
Urban-Rural Area of Residence										
Mean (SD) [Missing %]	2.2 (1.0) [0.8%]	3.0 (1.1) [0.4%]	2.1 (1.1) [0.9%]	2.4 (1.2) [3.1%]	2.9 (1.1) [0%]	2.5 (0.98) [0.5%]	2.3 (1.3) [0.5%]	2.7 (1.3) [0%]	2.7 (1.0) [0.3%]	2.5 (1.2) [0.8%]
Age										
Mean (SD) [Missing %]	47 (15) [5.2%]	45 (15) [0%]	45 (17) [0%]	39 (16) [0%]	52 (17) [0%]	51 (17) [0%]	39 (15) [0%]	46 (18) [2.5%]	44 (16) [0.1%]	45 (17) [1%]
Education										
Mean (SD) [Missing %]	2.9 (1.5) [2.1%]	3.7 (1.3) [0.4%]	2.9 (1.3) [0.5%]	2.4 (1.5) [6.6%]	2.5 (1.4) [2.7%]	3.0 (1.8) [1.8%]	2.8 (1.4) [0%]	3.5 (1.2) [0%]	3.3 (1.5) [0.2%]	3.0 (1.5) [1.6%]
Income										
Mean (SD) [Missing %]	3.1 (1.4) [18.3%]	2.6 (1.1) [12.9%]	3.1 (1.3) [51.5%]	3.2 (1.4) [45.6%]	3.1 (1.4) [7.7%]	3.2 (1.4) [9.5%]	3.1 (1.3) [7.1%]	3.0 (1.4) [5.1%]	3.0 (1.4) [4.6%]	3.1 (1.4) [21%]
Sex: Male (Base: Female)										
Mean (SD) [Missing %]	0.44 (0.50) [0%]	0.49 (0.50) [0.8%]	0.45 (0.50) [0%]	0.44 (0.50) [0%]	0.48 (0.50) [0%]	0.47 (0.50) [0%]	0.50 (0.50) [0%]	0.35 (0.48) [0%]	0.45 (0.50) [0%]	0.44 (0.50) [0.1%]
Level of Interest in Politics										
Mean (SD) [Missing %]	2.2 (0.81) [1.9%]	3.0 (0.78) [0.7%]	2.2 (0.99) [0.7%]	2.0 (0.98) [3.8%]	2.7 (0.88) [2.1%]	2.5 (0.82) [3%]	2.3 (0.95) [0.8%]	1.8 (0.68) [3.6%]	2.2 (0.80) [0.5%]	2.2 (0.92) [2%]
Left-Right Ideological Placement										
Mean (SD) [Missing %]	3.0 (0.82) [45.5%]	2.9 (1.1) [10.7%]	3.6 (1.1) [41.4%]	2.8 (1.2) [73.7%]	2.7 (1.2) [23.3%]	3.2 (0.91) [46.2%]	3.0 (0.96) [61.4%]	2.6 (1.4) [81.3%]	3.0 (0.92) [3.9%]	3.1 (1.1) [47%]
Religious Attendance										
Mean (SD) [Missing %]	2.4 (1.1) [3%]	2.9 (1.2) [3.1%]	4.2 (1.8) [0%]	4.6 (1.5) [15.1%]	2.6 (1.6) [3%]	2.5 (1.7) [3.2%]	5.1 (1.3) [0.3%]	2.2 (1.2) [0%]	2.9 (2.1) [0.5%]	3.3 (1.9) [3.1%]

Note: Missing percentages inside the brackets reflect the missingness shares per respective sample size (*N*). Given our exclusion criteria on sleep patterns, *Sleep Duration* and *Chronotype* do not have missing values.

5. Robustness tests

5.1. Survey seasons and days

We test whether the season and day of measuring sleep-wake preferences matter for the association between the amount of sleep, midpoint timing of sleep and voting (Mattingly et al., 2021; Putilov et al., 2020). Accordingly, within our multilevel models with random intercepts and random *Sleep Duration* and *Chronotype* slopes varying across the election types nested into the surveyed countries, we also added random intercepts and random *Sleep Duration* and *Chronotype* slopes varying across the days of sleep measurement, which are nested into seasons of the survey fields (see Tables 4–6 and Research Note 7 in the Online Appendices). We find out that additionally accounting for day and season grouping cancels out the ideology's confounding effect with *Sleep Duration* in the Netherlands and Russia. There remains the counter-intuitive association between greater sleep and lower turnout in all nine countries, irrespective of covariates (H_1). Further, the expected positive relationship between greater morningness and higher *Turnout* holds in all countries except Russia with and without controls (including ideology) and in Russia when controlling urbanization or all covariates plus ideology. Nevertheless, the season and day grouping diminish the strong association in all countries, including the previously significant association in South Korea, when the model has all covariates plus religiosity (H_2).

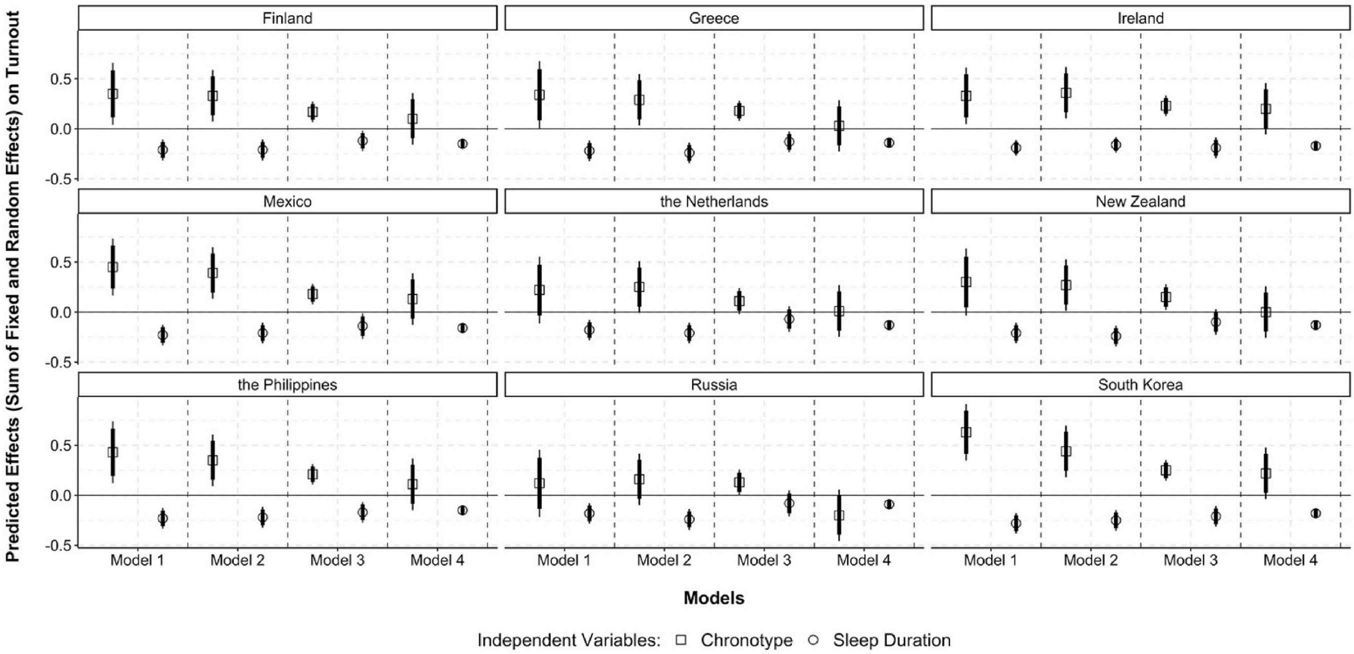

Fig. 1. Predicted effects of sleep duration and chronotype on turnout.
Note: The values on the y-axis are standardized logistic regression coefficients. Those predicted effects of sleep duration and chronotype for each surveyed country are estimated per respective model of Table 2 in the Online Appendices. There are no control variables in Model 1. Model 2 only controls urbanization. Model 3 includes all covariates plus ideology, whereas Model 4 contains all controls plus religiosity. The thin lines are for the 99% CIs and the thick ones for the 95% CIs.

5.2. Other individual- and country-level control variables

We test whether other individual- and country-level variables may weaken the links between sleep and turnout behavior. We consider whether religious denomination itself is a candidate confounder besides religious service attendance. Prior research has linked morningness more strongly to some religious belief systems (e.g., Roman-Catholic denomination compared to Protestantism and atheism) (Jankowski et al., 2014) and voting habit formation is linked to religious traditions' time spent between worship practices and secular affairs, including political activities (Smith and Walker, 2013). Considering the extensive literature about how sleep preferences vary cross-nationally due to geography (Randler et al., 2015), we also examine whether residential region's latitude, longitude, and mean temperature during the field of survey and season of the turnout election are linked to the alignment between sleep and voting. Moreover, given the different understandings of elections (e.g., accountability of the elected officials v. resolution of the intra-elite conflicts) as well as varying costs-benefits of voting (e.g., time consumption v. possibility of being oppressed) across democratic and non-democratic regimes (Martinez i Coma, 2016), we wonder about whether the degree of a polity's democratic nature might structure not only individuals' turnout behavior but also sleep preferences and so impair the link between the two. Lastly, we look into whether the time between the elections (of the turnout questions) and the survey fields may cause some respondents to underreport (or misremember) their actual non-voting behavior, inflating the reported turnout behavior (Kuhn et al., 2021).

Accordingly, we run our multilevel models with all main covariates plus the categorical religious denomination, geographical-seasonal characteristics, electoral democracy, and years since the last election (see Tables 7–9 and Research Note 8 in the Online Appendices). The negative association between greater sleep duration and higher turnout is present in six out of eight countries (e.g., Finland, Ireland, Mexico, New Zealand, the Philippines, and South Korea). As for *Chronotype*, while the relation between morningness and voting is strongly positive in three out of eight countries (e.g., Ireland, the Philippines, and South Korea), it is strongly negative in the Netherlands, contrary to what we expect (H_2).

5.3. Non-linear conceptualization and testing

Given the existing literature on sleep duration and turnout that informed H_1, we further examined the unexpected negative alignment between greater *Sleep Duration* and *Turnout*. Our main point of departure is whether our (as well as the scholarship's) linear theorizing of the relationship between sleep duration and turnout captures the true nature of the observed relationship. Bechler et al.'s (2021) questioning of the common linear attitude-behavior association conceptualization led us to think of another overlooked theoretical possibility. That is, an excessive amount of sleep may also dampen the potential to participate in politics.

Past research shows that oversleeping (excessive sleep duration) is linked to impaired mental and physical health, such as memory failures (Xu et al., 2011), anxiety disorder and depression (van Mill et al., 2014), chronic inflammation (Grandner et al., 2013), diabetes (Shan et al., 2015), and obesity (Chaput et al., 2008). Then, the shortest and longest sleep duration may differentially weaken civic participation by damaging the psychophysiological resources enabling political involvement. Within the boundary conditions of conventional resource theory, the negative relationship between shorter sleep duration and voting is understandable (e.g., inadequate sleep weakening turnout potential through lower energy). On the other hand, the health consequences of excessive sleeping and the likely negative spillovers in pro-social behaviors such as turnout may indicate that sleep is not merely a socioeconomic resource with monotonic positive links to political participation. As a result, unlike fiscal resources that increase political participation by greater amounts, sleep duration may suppress political participation after exceeding certain recommended ranges (e.g., 6 to 10 h) (Hirshkowitz et al., 2015). This non-linear understanding of the relationship between sleep and voting does not imply that the resource theoretical framework is inappropriate for understanding turnout in general, but rather that healthy sleep rather than sleep duration per se is a crucial resource for participation.

To examine the potential for a curvilinear relationship between sleep duration and voting, we run a similar multilevel logistic regression estimation by including second-degree polynomial term of *Sleep Duration,* named *Sleep Duration Squared*, into the equation (see Tables 10–12 in the Online Appendices). We find that this quadratic model provides a trend with an inverted u-shape curve where both insufficient and excessive sleep appear to depress turnout in all countries except Russia (see Fig. 2). Contrary to our earlier expectations, oversleeping may have a more deleterious effect on turnout than insufficient sleep, which likely explains the unexpected negative coefficients in the linear test of H_1. Nonetheless, the curve is least pronounced in New Zealand and Greece, where the negative effects on turnout are primarily concentrated among those who sleep too much rather than those who sleep too little; these cases deserve additional attention in future research to better understand how they differ from cases with a pronounced curve (e.g., Ireland).

To better understand the substantive significance of these findings, we calculated effect sizes for changes in sleep duration on the probability of voting. We compare the probability of *Turnout* at the peak *Sleep Duration* hours (e.g., the hours below and above which turnout declines in Fig. 2) to other sleep duration hours. For this analysis, we interpret a roughly 1% change in turnout as a substantively meaningful effect. We benchmark the appropriate sleep amount range between 6 and 10 h as per Hirshkowitz et al. (2015). We take the values below and above this recommended range as sleep deficiency and oversleeping accordingly. Fig. 3 shows that sleep debt has a substantively negative impact on voting in four countries (Ireland [−4.45% to −2.28%], Mexico [−1.34%], the Philippines [−1.07%]), and Finland [−0.96%]. We also discover that sleeping too much also negatively affects voting in eight countries (all except for Russia, from −0.96% in New Zealand to −6.38% in Ireland). Interestingly, in four countries (Finland [−3.22 to −1.09%], Ireland [−6.38 to −1.75%], Mexico [−3.45 to −1.05%], and South Korea [−3.64 to −1.44%]), the negative effects of sleeping too much begin at or near the midpoint of the recommended healthy sleep amount (8 h). In short, the magnitude of the effect of sleep duration on turnout is similar in magnitude to that of moving across one to two income categories (on a five-point scale). In the same multilevel polynomial logistic regression model, the population-level differences in the predicted probabilities of voting at the mid-income level (with the average predicted probability of 73.13%) compared to others are the following (at 0.01 levels of significance): −5.8% at the lowest-income level, −2.84% at the low-income level, 2.68% at the high-income level, and 5.21% at the highest-income level.

5.4. Excluded sample

We exclude the sample with abnormal sleep patterns (e.g., sleep duration fewer than 2 h or more than 18 h, bed time after 06:00 or before 19:00, or wake time after 15:00 or before 04:00) from the main analyses, as applied by Ksiazkiewicz (2020). The goal of these exclusion criteria was to eliminate respondents with extreme sleep patterns (e.g., extremely excessive and insufficient sleep and/or circadian rhythms potentially symptomatic of sleep disorders such as irregular sleep-wake syndrome and/or shift work that does not reflect their underlying sleep preferences) or whose responses reflect measurement error rather than their actual sleep behaviors.

Of the initial pooled sample (N = 12,205), 622 participants are removed by the exclusion criteria and 27 respondents are also dropped

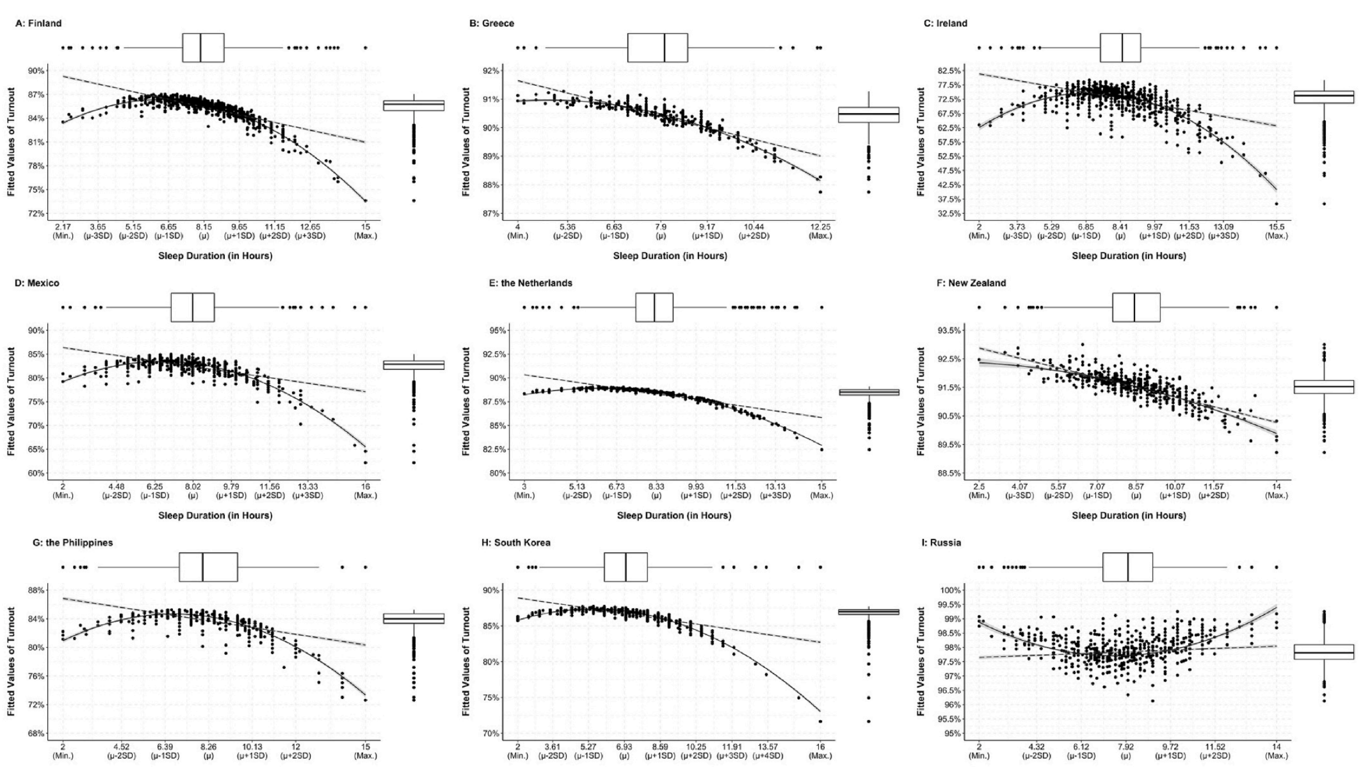

Fig. 2. Fitted values of turnout by sleep duration and sleep duration squared.

Note. The most complex model specification for this multilevel polynomial logistic regression is with random intercepts and random *Sleep Duration* and *Chronotype* slopes varying across the election types nested into the surveyed countries and random intercepts and random *Sleep Duration* and *Chronotype* slopes varying across the days of sleep measurement, which are nested into seasons of the survey fields. The covariates are *Urban-Rural Area of Residence*, *Age*, *Education*, *Income*, *Sex*, *Level of Interest in Politics*, and *Religious Attendance*. To obtain the fitted values of turnout by sleep duration and sleep duration squared per country from Model 1 of Table 10 in the Online Appendices, we keep the remaining control and grouping variables at their (population) mean values (e.g., 0s). The dashed line is the linear smooth line with 95% CI, and the solid line is the squared smooth line with 95% CI. Min. and Max. mean minimum and maximum values, respectively, μ denotes mean value, and SD stands for standard deviation. The relationship between *Sleep Duration* and *Turnout* is significant curvilinearly in all countries except Russia ($p > 0.10$).

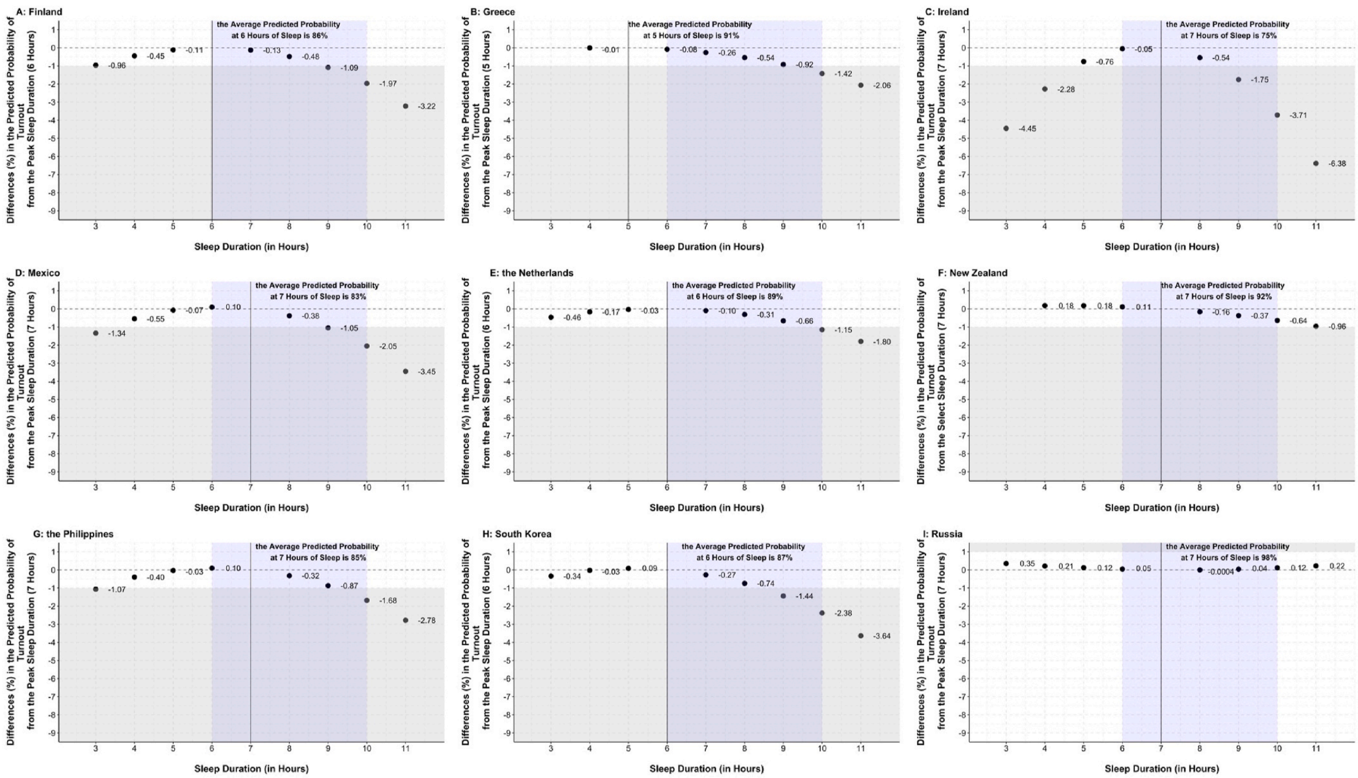

Fig. 3. Differences in the predicted probabilities of turnout compared to the peak sleep duration hours.
Note. The plot is based on Model 1 of Table 10 in the Online Appendices. The percentage point differences in the predicted probability to vote are in comparison to the peak sleep duration hours in Fig. 2 on a per-country basis (e.g., the hours below and above which turnout declines). The horizontal thin lines are for the 99% CIs and the horizontal thick lines are for the 95% CIs. All the values are meaningful at 0.01 level of significance. CIs may not be visible because they are tight. We put the differences in percentage values next to the respective points for illustrative purposes. The healthy sleep duration (six to 10 h), as recommended by Hirshkowitz et al. (2015), is shaded in blue on the x-axis. The substantive effects (e.g., differences in percentage points above 1% and below −1%) are shaded in gray on the y-axis. Because the trend in New Zealand is heavily downward in Fig. 2, the select sleep duration value (7) is not the peak value, but rather the mid-point of the range between 3 and 11. In Greece and New Zealand, there are no respondents with 3 h of sleep, so the respective values are missing. . (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

due to missing sleep measures (see f. n. 2). Within the excluded sample ($N = 622$), 7.07% of the respondents are dropped because of sleep and wake timing and sleep duration, 25.88% due to sleep and wake timing, 47.91% owing to sleep timing and duration, 18.81% for sleep timing only, and 0.32% since wake timing only. Fig. 1 in the Online Appendices shows the distribution of sleep patterns across the excluded and included samples. Table 13 in the Online Appendices shows the percentages of exclusion criteria used to eliminate participants across countries.

In light of our findings, another question could be raised about whether including the previously excluded sample with abnormal sleep patterns in the analyses would lead to major changes in the results. Then, we run our main models by including the excluded sample (see Table 15 in the Online Appendices). Including these participants in the analysis leads to similar conclusions for chronotype and turnout (generally significant effects attenuated in most contexts by religiosity) and for the effect of controlling for urbanization (very little). For sleep duration and turnout, we see the same negative linear relationship as before, although more attenuated by the inclusion of controls than in Fig. 1 (rendered non-significant in all cases except South Korea). The non-linear relationships in Figs. 2 and 3 are particularly muddied by the inclusion of the excluded participants (those who reported sleeping less than 2 h, more than 18 h, or at irregular times) (see Tables 17–19 and Fig. 2 in the Online Appendices). Regardless of whether we use our main base hour (20:00) or much earlier timings (e.g., 16:00, 17:00, 18:00, and 19:00) for centering chronotype, the results with the excluded sample are essentially the same (see Research Note 9 in the Online Appendices).

Where these results deviate from the analyses above (particularly for the curvilinear effects of sleep duration), it is unclear whether these changes are the result of measurement error introduced by the excluded participants (thereby concealing a true curvilinear effect) or the result of substantively different processes occurring among those participants that should be modeled in their own right. Future research should examine, for example, whether systematic factors such as shift work, diagnosed sleep pathologies, or comorbidities could account for the relationship between sleep and turnout among those with irregular sleep patterns. Nonetheless, because most of the sample meets the exclusion criteria and the curvilinear effect is observed across national contexts in those cases, we believe that establishing the conditions under which this relationship occurs should remain an area of future research.

6. Conclusion

Our study extends prior work on sleep preferences and turnout in several ways. First, it conducts the first cross-national nine-country analysis of sleep duration and voting, including the first such analysis for each of those countries (as previous work focused on the U.S.). Second, our study is the first to consider the alignment between sleep-wake timing preference (chronotype) and voting. Third, our study is the first to include tests of several relevant explanations, such as light pollution, religiosity and religious denomination, the extent of electoral democracy, time duration between the election and the interview, geography, and non-linearity, for why sleep and political participation may be associated.

As for our first hypothesis (H_1: greater sleep duration – higher voting relationship), like in the U.S., getting enough sleep is associated with a higher likelihood of turning out to vote if we compare insufficient sleep to healthy sleep. Yet, unlike the scholarship's orthodox linear understanding of the association, we observe this relation only if we specify our models curvilinearly to account for excessive sleep. From both a theoretical and a methodological perspective, our findings suggest that insufficient and excessive sleep might differentially diminish the likelihood to vote in all countries except Russia (with weaker effects for insufficient sleep in Greece and New Zealand, as well). The insignificant opposite pattern in Russia may signal an outlier case meriting further investigation in future research. Since Russia is the country with the highest turnout rate in our data, we entertain three possibilities, which are beyond the scope of our study to resolve. First, those Russian respondents sleeping too little or too much might be imbued with fatigue and impaired memory performance exaggerating the self-reported turnout behavior unconsciously (Kopasz et al., 2010). Second, those Russian participants with chronic fatigue due to sleep deficiency and excess might be psychologically as well as socioeconomically more susceptible to authoritarian coercion or bribery to turn out to vote (Ross, 2018). Third, the social desirability bias to report voting in Russia may be particularly strong due to Russia's authoritarian political system, regardless of a respondent's sleep patterns (cf. Kalinin, 2016). All in all, nonetheless, understanding how over- and under-sleeping affect access to the voting booth and what institutional reforms can address this problem by ensuring an adequate amount of sleep or at least attenuating this link remains a pressing comparative political behavior research topic.

Another set of results comes from the analyses of our second hypothesis (H_2: morning chronotype – higher voting relationship). In line with our theoretical prediction, for the first time in the scholarship, we show that morningness is related to higher voting rates. However, the relationship is confounded by religious observance structuring sleep-wake cycle and civic participation potential. Future multi-national studies should prioritize higher quality measurement – for chronotype, like the midpoint of sleep on free nights from the Munich Chronotype Questionnaire (MCTQ) (Roenneberg et al., 2003), turnout, and some sensitive measures such as ideology – and larger sample sizes for greater statistical power. This would increase our confidence in these results and facilitate explorations of how policy interventions could bolster turnout through public education, health, and work policies that address the socioeconomic costs of the (a)synchronicity between the sleep-wake and the day-night cycles.

Concerning our third and fourth hypotheses (H_3 and H_4: light pollution as a confounder of the sleep duration/chronotype – voting relationship), urban-rural area of residence seems not to be a major explanatory factor. Nevertheless, considering the association between morningness and voting, future research should ponder how other sources of light pollution, such as artificial indoor lighting (e.g., mobile phones, tablet devices, and other screens)—destabilizing the human circadian clock at night (Navara and Nelson, 2007)—may affect the link between the sleep-wake timing preference and voting potential.

Sleep is a human universal psychobiological state that affects everyone. However, due to individual genetic and environmental heterogeneity, not everyone has the same chances of securing the harmony between the sleep-wake and day-night cycles and healthy sleep duration. Hence, the amount and timing of sleep is not always optimal for us to function properly in society (Montaruli et al., 2021). While policy recommendations may be implemented to encourage citizens to adopt healthy sleep habits (e.g., sleeping six to 10 h) and preferences in harmony with the social clock (e.g., the 9-to-5 workweek) (Centers for Disease Control and Prevention, 2017), we do not know whether and to what extent the recommended healthy sleep behaviors increase voter turnout across countries. In this regard, examining the relationship between the psychobiological features of sleep and turnout would help us reduce the unexplained variation in voting next to genetic and environmental effects (Ahlskog, 2021), provide a new ground for advocating for public policies that consider wide-ranging health implications of sleep on politics beyond extending polling hours and days (Urbatsch, 2017), such as improvements in work hour requirements, new light policies advocating smart electronic device and home lightning systems to minimize the negative effects of the artificial indoor lights at night on the circadian rhythm, public healthcare expenditures on sleep disorders, and promotion of physical activities to mitigate oversleeping at the population-level, and so better understand the participatory foundations of democracy attitudes in the future (Kostelka and Blais, 2018).

Given the links between sleep and voting, future work should also delve further into how and why sleep duration and chronotype are linked (or not linked) to other political participatory behavior. The link between the amount of sleep and conventional participatory civic behavior such as petition signing and donation to charities (Holbein et al., 2019) is one of the scholarly and administratively informative research lines in need of further investigation with cross-national (associational, experimental, and/or longitudinal) data and with an additional focus on chronotype. The relationship between sleep duration, chronotype, and other conventional political participation acts (e.g., attendance to campaign meetings and rallies, political party membership and participation in the activities of political parties, and contact with the elected officials about local or general issues) and also unconventional political participation behavior (e.g., boycott, protest, counter-protest, and online political participation), on the other hand, is an unexplored territory looking for fresh theorization and data collection endeavor and holding sizeable policy implications on education, family, health, and work.

Although one strength of our research is that it delivers a new perspective on the alignment between sleep preferences and behavior and turnout by using untapped multinational contexts with representative samples, the majority of our data rely on non-election studies from the ISSP Research Group, 2009 Leisure Time and Sports module (ISSP Research Group, 2009). It would be legitimate to ask whether surveying key political measures such as turnout without standard election study interview protocols and training would result in social desirability bias, which may affect our findings. The existing scholarship on public opinion provides evidence that there is the tendency of overreporting turnout (Jackman and Spahn, 2019). Then, given the previous finding that sleep deprivation is negatively related to the systematic error of social desirability (Barber et al., 2013), one might wonder whether the peak in turnout among respondents with adequate sleep on an inverted u-shape curve is due to the sleep measure itself or the cognitive effort energized by the adequate sleep duration to impress the interviewer. We see that the aggregate turnout rates in the non-election ISSP module are either no different or lower than the aggregate turnout rates in the election studies of the Comparative Study of Electoral Systems (CSES) (n.d.) Module 2 in the Philippines and Module 3 in Finland, Ireland, and Mexico, surveyed for the same elections as in the ISSP data (see Research Note 10 in the Online Appendices). This aggregate comparison in the four most accessible countries suggests that the direct self-reports of voting in the non-election ISSP module are not worryingly overstated. Nonetheless, future research should seek to extend analyses on the sleep and political participation links by controlling for social desirability bias in voting self-reports (Morin-Chassé, 2018).

Data availability

The replication data and code are available on Dataverse at https://doi.org/10.7910/DVN/WIG6FR.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.electstud.2022.102491.

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