The relationship between sleep time and self-rated health: an analysis based on Italian survey data

Guido Citoni[1]

ABSTRACT

BACKGROUND: a growing and broadly discussed literature has shown that the relationship between sleep duration and health is not linear. Not only are insomnia and insufficient sleep harmful to one's health, but excessive sleep too is also not beneficial. This study tests the association between self-rated state of health and the duration and pattern of sleep: we discuss the losses and costs in terms of quality of life deriving from excessive sleep time.

METHODS: we use an ordered probit specification, applied to the Italian Survey on the Use of Time (sample of Italians aged fifteen and over who keep a diary for a working day).

RESULTS: we show that greater sleep duration is negatively correlated both with self-reported state of health and with self-reported health satisfaction, while respondents' subjective *perceptions* of too much and too little sleep are associated with health conditions in the usual u-shaped way.

CONCLUSIONS: the negative impact of long sleep on self-reported health is confirmed. However, the effect of short sleep on health conditions is positive, while a measure of decreasing sleep quality - comprising number of interruptions of sleep, insomnia and napping - is correlated to some extent with decreasing health. The public health consequences are still to be explored: the potential gains from sleep restriction are substantial, but little is known about the causal link or the risks. Further research is needed before taking policy decisions.

Key words: Long sleep; Self-rated Health; Ordered Probit; Italy

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INTRODUCTION

People are usually worried by lack of sleep. Hypertension, diabetes and obesity seem to be related to insufficient sleep; an effect on mortality is also reported [1]. However, recent studies [2-12], including comprehensive surveys [13-15] and meta-analysis [16, 17], suggest, albeit sometimes with distinctions [18], that - via channels not yet fully understood - overall mortality may also be increased by *too much* sleep. Among the possible causes are increased risks of metabolic syndrome [19, 20], diabetes [21-25], psychiatric disorders such as depression

and alcohol abuse [26, 27], hypertension [28, 29], atherosclerosis [30, 31], coronary heart disease [32-34], stroke [35], obesity [36-38], adverse socio-demographic factors [39, 40], cancer [41], inflammation [42], physical function decline [43], osteoporosis [44] and so on [45-48]. And one recent study [49] correlates long sleep duration and insomnia with an additional health hazard, namely the risk of incurring a subsequent long-term disability at work.

This paper analyzes the association between sleep time and self-reported health, defined in two ways, i.e. as either health condition or health satisfaction. The topic has been explored elsewhere [50-52], in some instances without finding any correlation between greater duration of sleep and self-reported health. Our results, by contrast, find a clear negative correlation. The source of our data, namely the Italian Survey on Use of Time [53], does not permit testing any association with mortality, but our analysis retains its validity, given that the literature [54-55] has consistently shown the strong correlation between self-reported health and mortality. Of course, as the data are cross-sectional the correlation is not proof of any causal link between the self-reported measures of sleep and health. In the discussion, on the working hypothesis that the causal factor is sleep length, we set out some of the possible economic implications. Moreover, some other aspects of sleep also warrant study in relation to self-reported health: satisfaction with one's sleep (so as to capture the effect of the subjective components of sleep), the number of periods of sleep, and the specific effects of insomnia and naps on health. The impact of some specific correlates, such as stress that may bias analysis, and the main socio-economic factors characterizing individuals and households, should also be taken into account.

METHODS

Data

Our data come from the Italian Statistical Office's Survey on the Use of Time (ISTAT 2002-2003). The survey consists of general questions, and individuals are asked to fill out a highly detailed form (by 10-minute periods) recounting what they have done during the last day. This enables us to compute the minutes of sleep during the 24 hours by the individual (SLLE), the number of periods of sleep (NSLSP), any insomnia (INS), and napping (NAP). Respondents fill in the time-use form for either a working day or a weekend day. We took only working-day diaries and restricted the sample to people over 15. The data also enable us to measure people's satisfaction with their sleep duration: we label the perception of having slept too much UTMSL, that of having slept too little, UTLSL. Finally, we were able to control for atypical days being reported. We ended up with a database of 15 550 individuals.

Estimation

The statistical technique chosen is an ordered probit framework, which is a routine tool for studying ordered variables (in this case, self-reported health status).

Our first definition of self-reported health (our HC variable) is derived from the question: "Would you say that, in general, your health is: very good, good, fair, poor, very poor"; this measures the respondent's *permanent* perceived state of health. The second definition (variable HS) derives from another question: "Thinking back over the last 12 months, are you satisfied with the following aspects of your life?" with four possible choices for health: satisfied, satisfied enough, somewhat unsatisfied, unsatisfied, plus "not applicable". Again the time span is quite wide, but the focus here is on the overlapping of actual and expected health, which captures a subjective attitude or perception.

The main estimation problem is to define what is *too much* and what is *too little* sleep. The literature is not particularly helpful here, because there is no golden rule for determining average, long and short duration of sleep: "long" may be defined as more than 8 hours or more than 9 hours, "short" as less than 7 hours or less than 6 hours. We accordingly used a pragmatic approach, running a series of different specifications, depending on different values of two indicator variables TMSL and TLSL, i.e. respectively respondents sleeping more and less than the average. In the first specification TMSL is more than 480 minutes and TLSL less than 420 minutes, the average amount of sleep thus ranging from 7 to 8 hours, which is the benchmark: negative signs for the

variables mean that they are correlated with poorer health *with respect to the average*. In specification 2, TMSL is more than 510 minutes and TLSL less than 420; in the third, the cut-offs are 540 and 420 minutes, in the fourth 510 and 390, in the fifth 540 and 360.

A second problem is defining sleep quality: we construct an indicator variable, primarily for *fragmented* sleep. The reference (high) quality (QUAL1) is having had just one period of sleep (mainly at night), without insomnia or napping. QUAL2 is defined by more than one period of sleep but without insomnia or naps. QUAL3 is defined as one period of sleep and one of insomnia (no nap), QUAL4 as more than one period of sleep, some insomnia but no nap, QUAL5 as more than one period nap, but no insomnia, and QUAL6 as more than one period of sleep with insomnia and nap.

Alternative specifications dispense with the quality variable, accompanying sleep duration with two dummy variables *insomnia* (INS) and *nap* (NAP), since their relation with duration, at least for insomnia, is not linear [56].

Self-reported health can also be declined in terms of HRQL (Health Related Quality of Life) scores. In order to infer the effect of sleep duration on the quality of life, measured on the usual scale of 0 to 1, the value of the coefficients must be converted into gains or losses in quality of life by rescaling them. The transformation used (Cutler-Richardson [57]) is obtained by dividing the value of the coefficients by the difference between the upper and lower cut-off points of ordered probit estimates, which measures the range over which coefficients are calculated. Table 1 gives a full description and coding of the variables presented in all the specifications.

Model

The function to estimate is:

$$Health_i = f(\sum_j Sleep, \sum_k Work, \sum_m Illnessess/Impairments/Symptoms, \sum_n Socio\text{-}Economic) + \varepsilon$$

in which the j factors linked to sleep, are: duration, sleep quality (expressed as number of periods, having naps, insomnia), satisfaction with sleep duration; the *K* factors expressing work conditions are: job position, sector of activity, working at night, working overtime, evening work, shift work, having plenty of time without anything to do, having been out of work because of poor health of children; the *m* factors proxying health conditions are: having stayed home from work in the last 7 days, being unable to work full time because of health conditions, having experienced stress and sources of stress, the number of periods of illness, the number of periods of treatment, and the number of medical examinations; the *n* socio-economic factors are: age, sex, marital status, education, source of income, household income, household wealth, number of household members, region of residence.

RESULTS

In Table 2 we report population characteristics of some variables (weighted data).

The relationship between health conditions and sleep duration is shown in Figure 1, which gives the median bands and a fitted polynomial fractional line, together with its confidence interval (predicted consal) [58]. The decline in health (after a small increase) as sleep duration increases is evident though very irregular.

Tables 3 and 4 give the effect of sleep variables on our two health variables, in ten different specifications. The explanatory variables in Table 3 are sleep duration, sleep quality and satisfaction; in Table 4, in lieu of sleep quality we have insomnia and napping . For all specifications we report the Pseudo R2 measure of goodness of fit.

We have also included, as additional explanatory variables, all the variables discussed in the model description. The full results are not given here for brevity but are available from the author on request. The equations pass the STATA Reset test of specification based on regressing the health variables on fitted values and on squared fitted values. Multicollinearity is not a problem, in that the correlations among explanatory variables are sufficiently low: the maximum value of VIF is 3.6 and the average is below 1.5.

Table 5 reports losses/gains in quality of life for specifications 6 to 10 (the full set is available upon request by the author):

DISCUSSION

The results are quite stable over the different specifications, except for some variables

TABLE 1

DESCRIPTION OF VARIABLES

VARIABLE	DESCRIPTION	CODING
HC	Self-reported health conditions, Ordinal	1-Very Poor, 2-Poor, 3-Fair, 4-Good, 5-Very Good
HS	Self-reported health satisfaction, Ordinal	1- Unsatisfied, 2-Somewhat unsatisfied, 3-Satisfied enough 4-Satisfied
SLLE	Number of daily minutes of sleep, Cardinal	
NSLSP	Number of periods of sleep, Cardinal	
TLSL	Having slept too little, Binary (0-1)	Specifications 1 & 6: 1 if SLLE<420 Specifications 2 & 7: 1 if SLLE<420 Specifications 3 & 8: 1 if SLLE<420 Specifications 4 & 9: 1 if SLLE<390 Specifications 5 & 10: 1 if SLLE<360
TMSL	Having slept too much, Binary (0-1)	Specifications 1 & 6: 1 if SLLE>480 Specifications 2 & 7: 1 if SLLE>510 Specifications 3 & 8: 1 if SLLE>540 Specifications 4 & 9: 1 if SLLE>510 Specifications 5 & 10: 1 if SLLE>540
QUAL1	Quality of sleeep 1, Binary (0-1)	1 if: NSLSP=1 & INS=0 & NAP=0
QUAL2	Quality of sleeep 2, Binary (0-1)	1 if: NSLSP>1 & INS=0 & NAP=0
QUAL3	Quality of sleeep 3, Binary (0-1)	1 if: NSLSP=1 & INS=1 & NAP=0
QUAL4	Quality of sleeep 4, Binary (0-1)	1 if: NSLSP>1 & INS=1 & NAP=0
QUAL5	Quality of sleeep 5, Binary (0-1)	1 if: NSLSP>1 & INS=0 & NAP=1
QUAL6	Quality of sleeep 6, Binary (0-1)	1 if: NSLSP>1 & INS=1 & NAP=1
UTMSL	Perception of having slept too much, Binary (0-1)	1 if yes
UTLSL	Perception of having slept too little, Binary (0-1)	1 if yes
INS	Having had insomnia, Binary (0-1)	1 if yes
NAP	Having had nap, Binary (0-1)	1 if yes

FIGURE 1

HEALTH CONDITIONS AND SLEEP LENGHT

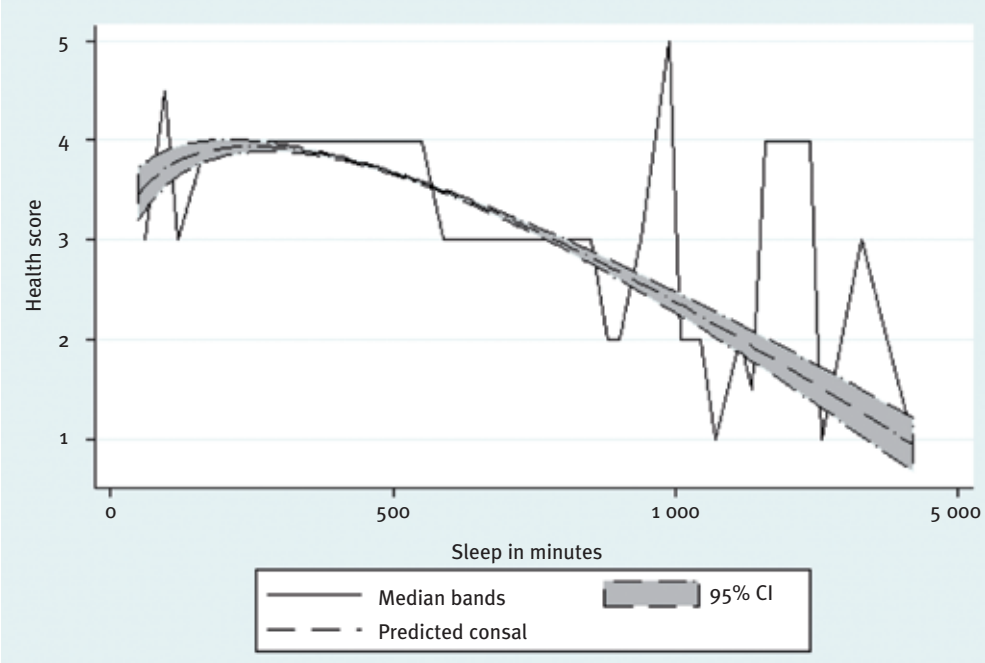

TABLE 2

CHARACTERISTICS OF THE POPULATION			
VARIABLE	MEDIAN	FREQUENCY (NUMBER OF CASES)	INTERQUARTILE RANGE
Age	45		32-62
Sex		Males 47.9% (7 447)	
Marital status		Married 60.2% (9 363)	
SLLE	480		440-540
NAP		Yes 13.2% (2 047)	
NSLSP	1		1-1
HS		Unsatisfied 4.1% (644) Somewhat unsatisfied 13% (2 023) Satisfied enough 67.4% (10 478) Satisfied 15.5% (2 405)	
HC		Very poor 0.9% (140) Poor 4.8% (751) Fair 35.8% (5 562) Good 44.4% (6 909) Very good 14.1% (2188)	
Satisfaction with sleep		Satisfied 58.8% (9 139) Too much 2.7% (415) Too little 38.6% (5 996)	
INS		Yes 5.6 % (878)	
Stress		Never 31.4% (4 883) Sometimes 49.2% (7 657) Often 14.3% (2 228) Always 5% (782)	
Source of stress Missing (4 883)		General situation 34.1% (3 637) Work 27.5% (2 934) Financial situation 9.5% (1 016)	
Typical day		Typical 86.1% (13 396)	

measuring the quality of sleep. The first finding is that *too little* sleep is always associated with better self-reported health conditions HC and health satisfaction HS, while *too much* sleep, however defined (more than 8, 8½ or 9 hours), always has a negative correlation with both health variables; and the effect is greater, the greater the duration of sleep.

Among the other variables, insomnia has the expected negative sign for both HC and HS: the value in all specifications is rather stable and quite high for the HC equation. However, if we examine the variable constructed for sleep quality, insomnia is not the driving component; indeed, when coupled with fragmented sleep its impact on the variable QUAL4 is positive rather than negative. In accordance with the literature [59], we also find a negative relationship for the after-lunch nap. Its adverse health effect is comparable to that of insomnia in the HC equation and is stronger in the HS equation. And if combined with fragmented sleep and possibly insomnia, napping has a negative impact on HC and HS through the variables QUAL5 and QUAL6.

The effect of fragmented sleep on health quality is quite straightforward: the pure effect of more than one period of sleep at night (QUAL2) is negative with certainty for both HS and HC.

Finally, for satisfaction with length of sleep, the results are stable both for HC and for HS. The feeling of having slept too much and that of having slept too little both affect health conditions and health satisfaction negatively, although the effect of too much sleep is stronger. The difference in sign between the effects of the actual amount of sleep shortfall and the *feeling* of shortfall may conceal pathologies such as OSAS or may simply reflect the differing needs of individuals.

The correlates and confounding factors usually have the expected signs and their

TABLE 3

ORDERED PROBIT ESTIMATES FOR HEALTH CONDITIONS AND HEALTH SATISFACTION. SPECIFICATIONS 1 TO 5

HEALTH VARIABLE	SLEEP VARIABLES	SPECIFICATION 1 PSEUDO R^2=0.1888	SPECIFICATION 2 PSEUDO R^2=0.1894	SPECIFICATION 3 PSEUDO R^2=0.1896	SPECIFICATION 4 PSEUDO R^2=0.1894	SPECIFICATION 5 PSEUDO R^2=0.1895
	VARIABLE	COEFFICIENT*	COEFFICIENT*	COEFFICIENT*	COEFFICIENT*	COEFFICIENT*
HC	TLSL	0.0522232	0.0538247	0.065615	0.0518436	0.064326
	TMSL	-0.0869055	-0.1231417	-0.1526635	-0.1285549	-0.1601054
	QUAL2	-0.0938067	-0.08024	-0.0635843	-0.0827912	-0.067717
	QUAL3	-0.0104629	n.s	n.s.	n.s.	n.s.
	QUAL4	0.0412625	0.0435749	0.044959	0.0456247	0.0479222
	QUAL5	-0.0499912	-0.0292183	-0.0119631	-0.0296976	-0.0136884
	QUAL6	-0.542176	-0.5214005	-0.4989301	-0.5209154	-0.4985462
	UTMSL	-0.3070406	-0.3050501	-0.3041676	-0.3042123	-0.3034664
	UTLSL	-0.1271118	-0.1328528	-0.1327635	-0.1324523	-0.1312281
		PSEUDO R^2=0.1573	PSEUDO R^2=0.1579	PSEUDO R^2=0.1581	PSEUDO R^2=0.1579	PSEUDO R^2=0.1581
HS	TLSL	0.0360002	0.0336007	0.046071	.0225319	0.0293117
	TMSL	-0.0826824	-0.1317356	-0.1640701	-0.13628	-0.1700553
	QUAL2	-0.0411958	-0.0277249	-0.0089044	-0.0293506	-0.0117036
	QUAL3	0.0178853	0.0248089	0.0360566	0.0284385	0.04196
	QUAL4	0.0595921	0.0606499	0.0617394	0.0622192	0.0643327
	QUAL5	-0.0345727	-0.0136846	0.0052652	-0.0141883	0.0038326
	QUAL6	-0.2531118	-0.2332787	-0.2087726	-0.2330176	-0.2085694
	UTMSL	-0.2355083	-0.2288849	-0.2276829	-0.2283566	-0.2272031
	UTLSL	-0.1611013	-0.1629483	-0.1627769	-0.1624223	-0.1614283

*The coefficients given are all significant at 1% level; "n.s." = not significant

coefficients are generally highly significant. To mention some of those discussed in the literature, let us consider stress factors. A constant or frequent state of stress affects health adversely compared with a benchmark of non-stress or only occasional stress. The baseline source of stress is poor health (of self or family members). All the other sources have positive signs, indicating an improvement with respect to the baseline.

Quality of life

From Table 5, using the variable HC, we can say that too much sleep in specification 9 (more than 8½ hours) is associated with a loss of quality of life that can be estimated at 2.7%; too little sleep (less than 6½ hours) is associated with a gain of around 1.1%. It is interesting to consider the sensitivity of these results: in specification 10, extending the period of reference, sleeping more that 9 hours is associated with a 3.4% loss in quality of life, and the loss increases with the duration of sleep. The same apparently goes for sleeping less: under 6 hours, the gain in quality of life increases to 1.5%. However, this is calculated with respect to a *normal* duration that now ranges from 6 to 9 hours, including some long sleepers whose health conditions are worse than in the previous definition of normality (6½ to 8½ hours). Napping also diminishes the quality of life. The amplitude of the loss varies with the specification, ranging from 1.5% to 2.2%. Insomnia is associated with a 1.9% loss in quality of life. Dissatisfaction with self-perceived oversleeping reduces quality of life by about 6.6%, while the feeling of sleeping too little produces only a 2.9% decrease.

The health satisfaction variable HS shows a similar sensitivity effect. The loss for oversleepers increases from 3.9% in specification 9 to 4.8% in specification 10, while the gain for short-sleepers

TABLE 4

ORDERED PROBIT ESTIMATES FOR HEALTH CONDITIONS AND HEALTH SATISFACTION. SPECIFICATIONS 6 TO 10

HEALTH VARIABLE	SLEEP VARIABLES	SPECIFICATION 6 PSEUDO R^2=0.1880	SPECIFICATION 7 PSEUDO R^2=0.1884	SPECIFICATION 8 PSEUDO R^2=0.1886	SPECIFICATION 9 PSEUDO R^2= 0.1884	SPECIFICATION 10 PSEUDO R^2=0.1885
	VARIABLE	COEFFICIENT*	COEFFICIENT*	COEFFICIENT*	COEFFICIENT*	COEFFICIENT*
HC	TLSL	0.0551239	0.056854	0.0681335	0.0546309	0.0691375
	TMSL	-0.0839525	-0.1211477	-0.1506703	-0.1269233	-0.1584003
	INS	-0.09042	-0.0899164	-0.0872182	-0.087922	-0.0842564
	NAP	-0.1018097	-0.086088	-0.0697711	-0.0866199	-0.0713937
	UTMSL	-0.3088588	-0.3035767	-0.3027771	-0.3026899	-0.3020326
	UTLSL	-0.132591	-0.1338015	-0.1337242	-0.133372	-0.1321628
		PSEUDO R^2=0.1570	PSEUDO R^2=0.1576	PSEUDO R^2=0.1579	PSEUDO R^2=0.1576	PSEUDO R^2=0.1578
HS	TLSL	0.0376906	0.0350471	0.0470985	0.0240102	0.0316452
	TMSL	-0.08098	-0.1292521	-0.160634	-0.1339643	-0.1667582
	INS	-0.0112948	-0.0108612	-0.0082299	-0.0091629	-0.0054079
	NAP	-0.0686849	-0.0498761	-0.0322856	-0.0503796	-0.0336189
	UTMSL	-0.2345319	-0.2280212	-0.2269401	-0.2274692	-0.2264403
	UTLSL	-0.161866	-0.1636002	-0.1634159	-0.1630536	-0.1620449

*The coefficients given are all significant at 1% level; "n.s." = not significant

TABLE 5

HRQL SCORES. SPECIFICATIONS 6 TO 10

HRQL	SLEEP VARIABLES	SPECIFICATION 6	SPECIFICATION 7	SPECIFICATION 8	SPECIFICATION 9	SPECIFICATION 10
	VARIABLE	HRQL	HRQL	HRQL	HRQL	HRQL
HC	TLSL	0.01202	0.01239	0.01483	0.01190	0.01506
	TMSL	-0.01831	-0.02640	-0.03280	-0.02766	-0.03449
	INS	-0.01972	-0.01959	-0.01899	-0.01916	-0.01835
	NAP	-0.02220	-0.01876	-0.01519	-0.01888	-0.01555
	UTMSL	-0.06736	-0.06615	-0.06592	-0.06596	-0.06577
	UTLSL	-0.02892	-0.02915	-0.02911	-0.02906	-0.02878
HS	TLSL	0.01105	0.01026	0.01379	0.00703	0.00926
	TMSL	-0.02374	-0.03785	-0.04702	-0.03923	-0.04882
	INS	-0.00331	-0.00318	-0.00241	-0.00268	-0.00158
	NAP	-0.02014	-0.01461	-0.00945	-0.01475	-0.00984
	UTMSL	-0.06876	-0.06678	-0.06644	-0.06662	-0.06629
	UTLSL	-0.04745	-0.04791	-0.04784	-0.04775	-0.04744

increases from 0.7% to 0.9%. Napping cuts quality of life by between 1% and 2%. Insomnia is associated with only a marginal loss in quality of life (0.2% to 0.3%). Finally, the feeling of oversleeping is associated with a loss in health satisfaction quite comparable to that in health conditions, while the feeling of not sleeping enough has nearly twice as large an impact (4.7%).

Economic implications

The importance of our findings would be evident if we could be confident of the direction of causality from sleep duration to health, and if we could attach a money value to the *potential* loss in quality of life. Taking the human capital approach, let us suppose that the value of one year of good quality life (QALY, Quality-Adjusted Life Year) is the average income that could be earned. If we take the average annual earnings of Italian employees [60] in 2003, we get a value of €19 339. Assuming, conservatively, that oversleepers are only those who sleep more than 9 hours, as in specification 10, the hypothetical loss of 3.44% would amount to €665. And as 24.7% of our sample was in the group sleeping more than 9 hours (which would correspond to about 3.9 million individuals in the entire population), we have a yearly loss of €2.62 billion. And this would be added to the loss due to excess mortality, reported in the literature. Finally, we could attach a money value to the direct increase in working time available thanks to sleeping less: if just half of the people sleeping 9 hours decided to sleep only 8 hours and work half an hour more, given estimated hourly earnings of €11 (the average income of €19 339 divided by 44 weeks and 40 hours per week), total output in Italy would increase by €2.36 billion.

CONCLUSIONS

Some studies have argued that just as dieting serves to cure obesity, there is a rationale for sleep restrictions to cure excess mortality [16]. In our view, one cannot disregard the extensive and lively debate over the validity of the relationship between long sleep duration and higher mortality [61-66] and skip directly to policy proposals, such as formal recommendations and guidelines or simple advice from GPs and other professionals. For while our work does add to previous findings on mortality effects, the result that too much sleep is also associated with losses in quality of life and that the potential gains from sleep restriction are large, at present our knowledge concerning the causality link and on possible illness and mortality effects deriving from reduced sleep is still too limited to warrant endorsement of a health policy calling for sleep restriction. However, if additional empirical and experimental studies find no adverse side-effects for such a strategy, the idea should be given renewed consideration.

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