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ORIGINAL RESEARCH

Does Daylight Savings Time Encourage Physical Activity?

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***Background*:** Extending Daylight Savings Time (DST) has been identified as a policy intervention that may encourage physical activity. However, there has been little research on the question of if DST encourages adults to be more physically active. ***Methods*:** Data from residents of Arizona, Colorado, New Mexico, and Utah ages 18–64 who participated in the 2003–2009 American Time Use Survey are used to assess whether DST is associated with increased time spent in moderate-to-vigorous physical activity (MVPA). The analysis capitalizes on the natural experiment created because Arizona does not observe DST. ***Results*:** Both bivariate and multivariate analyses indicate that shifting 1 hour of daylight from morning to evening does not impact MVPA of Americans living in the southwest. ***Conclusions*:** While DST may affect the choices people make about the timing and location of their sports/recreational activities, the potential for DST to serve as a broad-based intervention that encourages greater sports/recreation participation is not supported by this analysis. Whether this null effect would persist in other climate situations is an open question.

***Keywords*:** sports, recreation, public health intervention

Daylight savings time (DST) legislation was originally motivated by its potential to reduce energy consumption[1] but researchers have examined its implications for several health outcomes including workplace related accidents,[2,3] health events,[4–6] and the timing of sleep and work[7] with mixed results. The strongest evidence of DST's health consequences comes from studies that have linked it to reductions in automobile-related accidents.[8–13]

Public health officials working to identify policies that might reduce adults' obesity risks have recently begun to explore what role DST might play in people's physical activity choices. Hillman[14,15] notes that the early onset of dusk during non-DST limits individuals' accessibility to sports and recreation opportunities. If DST encourages greater sports/recreation participation, then extending DST could be viewed as a broad-based mechanism for increasing physical activity. Yet, to date there has been very little empirical testing of this proposition. Holmes et al[16] provide preliminary confirmation of Hillman's thesis as they find that urban pedestrian and nonmotorized vehicle trail traffic in Indianapolis significantly increased when DST began. In addition, Rosenberg and Wood,[17] using data from Australia, find that DST is associated with a shift in the time of day when people exercise. Finally, Wolff and Makino[18] use data from the 2005–2008 American Time Use Survey (ATUS) to examine how the extension of DST in 2007 may have altered indoor and outdoor leisure time. They report that the DST extension is linked to more time spent in outdoor leisure activities (eg, participating in sports, watching sports), and less time spent in indoor leisure activities (eg, watching television) between the hours of 3 PM to 7 PM.

In the current study, 2003–2009 ATUS data are used to assess whether DST is associated with time spent in moderate-to-vigorous physical activity (MVPA). DST may impact both outdoor and indoor MVPA as more evening daylight hours may lead to the substitution of outdoor MVPA for indoor MVPA. Both are included in our measure so we assess the net impact of DST on MVPA. The analysis capitalizes on the natural experiment created by the fact that Arizona does not observe DST. Arizona passed legislation exempting it from the 1967 Uniform Time Act because of high summertime temperatures. With the exception of the Navajo Nation, Arizona has not observed DST since 1968,[19] while the surrounding southwestern states have observed DST.

Methods

The ATUS is an annual survey of **A**mericans age 15 and older gathered over all 12 months of the year.[20] Each respondent provides a 24-hour time diary which is considered to be a valid and reliable measure of time use.[21–23] The current analysis focuses on diary reports of time spent in all activities that generate 3.0+ metabolic equivalent values (METs) which is the accepted threshold for moderate-to-vigorous physical activity (MVPA).[24] Tudor-Locke et al[25] have linked the ATUS time-use categories to the compendium of physical activity and we use their tables to identify the MVPA time-use categories. The categories that meet the MVPA threshold include activities such as exterior house cleaning, lawn and garden work, playing sports with household children, active transportation time (ie, walking or biking), as well as all forms of sports and exercise except billiards. (Some types of walking fall below the 3.0 METs threshold while others do not. We include all transportation related walking since we cannot always make meaningful distinctions using the ATUS.) The MVPA standard is used to measure physical activity because the Centers for Disease Control and Prevention (CDC) recommends that adults devote at least 150 minutes per week to MVPA to attain/maintain a healthy body weight.[24]

Analyses are restricted to adults age 18–64. American Indians are excluded because it cannot be determined from the ATUS as to whether they live within the Arizona Navajo Nation lands where they observe DST. Respondents are included if their dairy date falls between (a) the first Sunday in April and the last Sunday in October in the years 2003–2006, or (b) the second Sunday in March and the first Sunday in November in the years 2007–2009, as these dates reflect DST. Arizona respondents whose diary dates fall during

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these intervals form the treatment group. Colorado, Utah, and New Mexico respondents whose diaries fall in these intervals form the control group. Colorado, Utah, and New Mexico are selected for comparison because these states are in the Mountain Time Zone and their physical geography and climates are similar to Arizona's.

Multivariate analyses control for the respondent's sociodemographic characteristics.[20] For each state's largest metropolitan area, daylight hours for the day of the diary[26] and average monthly high temperature for the diary month[27] are linked to the ATUS file and included as climate controls as past research has found that individuals' time use choices are linked to weather.[28] Logistic regression is used to estimate the probability an individual spends time in MVPA activities on the diary day. A separate tobit regression, that makes adjustments for the censoring at zero minutes, is used to estimate time spent in MVPA. Analyses use the ATUS final weights to insure generalizability to the states in question. This study was deemed exempt by the University of Utah's Institutional Review Board.

Results

Table 1 reveals that the average sample member is almost 40 years old, has some college education, is employed, white, married, has 1 child at home, and lives in a metro area. About one-third of the respondents (N = 820) live in Arizona. Only 27% of respondents report spending time in MVPA activities on the diary day and the average amount of time spent in MVPA is slightly less than 23 minutes. When the MVPA measure is restricted to sports/recreation activities only, the mean time is 20 minutes suggesting that most MVPA time is sports/recreation time. As points of comparison, the mean time spent in all sports/recreation activities for all Americans age 15 and older in the 2010 ATUS was a little more than 18 minutes per day.[20] Analyses that use the National Health and Nutrition Examination Survey's (NHANES) accelerometer data report time spent in all MVPA averages 35 minutes per day for males and 21 minutes per day for females age 20–65.[29] Thus, the time spent in MVPA by residents of the southwestern U.S. appears to mirror the national average as measured by time diary methods but, as expected, it is lower than what is reported using accelerometer data that more precisely measures *all* MVPA.

Bivariate examinations of MVPA participation and time spent reveal no statistically significant differences by residential location. A little over 27% of Arizona respondents report spending some time in MVPA on the diary day while the corresponding percentage for residents of Colorado, Utah, and New Mexico is 26%. The average time spent in MVPA is 22 minutes for both groups.

The multivariate analyses presented in Table 2 reveal that participation and total time devoted to MVPA is associated with gender, age, education, employment status, race/ethnicity, number of children, calendar year, and hours of daylight on the diary day. These findings are consistent with prior research.[30–32] The likelihood of participation and the marginal increase in time spent in these activities rises significantly with the hours of daylight available. However, based

Table 1 Weighted Descriptive Statistics for ATUS Respondents Age 18–64 Living in Arizona, Colorado, New Mexico, and Utah Whose Diary Day was Recorded During Daylight Savings Time

Variable	Full sample (N = 2411) mean/proportion	Non-zero MVPA sample (N = 642) mean/proportion
Participates in any MVPA (1 = yes)	.27	1.0
Minutes spent in MVPA	22.58	70.71
Female (1 = yes)	.50	.49
Age (yrs)	39.80	39.23
Education (yrs)	13.64	14.10
Employed (1 = yes)	.80	.77
White non-Hispanic (1 = yes)	.71	.77
Black non-Hispanic (1 = yes)	.03	.02
Hispanic (1 = yes)	.23	.17
Asian (1 = yes)	.02	.03
Other race/ethnicity (1 = yes)	.01	.01
Married (1 = yes)	.60	.57
Number of minor children in home	.98	.87
Weekend or holiday diary day (1 = yes)	.27	.27
Diary year (2003 = 1 . . . 2009 = 8)	4.72	4.48
Lives in a metro area (1 = yes)	.77	.81
Average monthly high temperature (degrees Fahrenheit)	81.73	82.72
Hours of daylight on diary day	13.30	13.41
AZ resident (1 = yes)	.34	.35
CO, NM, or UT resident (1 = yes)	.66	.65

Abbreviations: MVPA, moderate-to-vigorous physical activity; ATUS, American Time Use Survey.

Source: American Time Use Survey, 2003–2009.

Table 2 Weighted Parameter Estimates of Multivariate Analyses Based on ATUS Respondents Age 18–64 Living in Arizona, Colorado, New Mexico, and Utah Whose Diary Day was Recorded During Daylight Savings Time

Variable	Odds ratios of MVPA participation (95% CI)	Tobit coefficients for MVPA tme (t-ratios)	Tobit marginal effects[b]
Intercept	—	–318.17 (–5.30)*	—
Female	.81 (.65–1.02)	–33.06 (–3.97)*	–7.71
Age	.99 (.98–.99)*	–1.31 (–3.66)*	–.33
Education	1.13 (1.07–1.19)*	8.28 (4.19)*	2.13
Employed	.62 (.47–.81)*	–42.78 (–4.11)*	–11.01
Black non-Hispanic[a]	.56 (.27–1.16)	–58.29 (–2.17)*	–15.00
Hispanic[a]	.67 (.50–.91)*	–34.52 (–3.16)*	–8.89
Asian[a]	1.52 (.74–2.84)	42.73 (1.72)	11.01
Other race/ethnicity[a]	.54 (.15–1.98)	–33.16 (–.74)	–8.54
Married	.89 (.69–1.15)	–12.34 (–1.31)	–3.18
# Minor children	.91 (.82–1.01)	–7.93 (–2.19)*	–2.04
Weekend/holiday	.98 (.77–1.25)	6.78 (.75)	1.75
Diary year (2003 = 1 . . .)	1.11 (1.05–1.17)*	7.39 (3.54)*	1.90
Lives in a metro area	1.31 (.99–1.72)	12.44 (1.22)	3.20
Average monthly high temperature	1.01 (1.00–1.02)	.34 (1.08)	.09
Hours of daylight on diary day	1.09 (.99–1.21)*	11.87 (3.24)*	3.06
Arizona resident (1 = yes)	1.00 (.74–1.33)	1.28 (.12)	.33
Pseudo R^2	.06	.02	

Abbreviations: MVPA, moderate-to-vigorous physical activity; ATUS, American Time Use Survey.

* $P < .05$, Source: American Time Use Survey, 2003-2009.

[a] The omitted group in this sequence of dummy variables are those respondents who identified their race/ethnicity as White non-Hispanic.

[b] Calculated at the mean/modal values for all of the independent variables.

on the estimated coefficients associated with the Arizona resident variable, we do not find that DST is associated with either the odds of participating in MVPA or the time spent in these activities.

Conclusions

While DST may affect the choices people make about the timing and location of their MVPA,[16,17] the potential for DST to serve as a broad-based intervention that encourages greater MVPA is not supported by this analysis. The empirical work holds hours of sunlight for the diary day and average high temperature for the diary month constant. Thus, the primary effect captured by treatment versus control group membership is the timing of sunrise and sunset. It would appear that shifting 1 hour of daylight from the morning to the evening has no impact on the MVPA of American adults living in the southwest.

It may be that DST serves to shift MVPA time from indoors to outdoors or from morning to afternoon/evening. It may also be that DST effects are climate specific. For instance, the effects may vary at other latitudes, during the winter months, or in parts of the country that have more inclement weather. All of the above are "open questions" that merit future research.

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