



Time use and associations with internalizing symptoms from 1991 to 2019 among US adolescents

Noah T. Kreski^{a,*}, Qixuan Chen^b, Mark Olfson^c, Magdalena Cerdá^d, Deborah S. Hasin^e,
Silvia S. Martins^f, Pia M. Mauro^g, Katherine M. Keyes^h

^a Columbia University, Mailman School of Public Health, Department of Epidemiology, 722 West 168th St, Room 733, New York, NY, 10032, USA

^b Columbia University, Mailman School of Public Health, Department of Biostatistics, 722 West 168th Street, Room 644, New York, NY, 10032, USA

^c Columbia University, Mailman School of Public Health, Department of Epidemiology, New York State Psychiatric Institute, Vagelos College of Physicians and Surgeons, Columbia University Irving Medical Center, Department of Psychiatry, 1051 Riverside Dr, New York, NY, 10032, Box 24, USA

^d New York University Grossman School of Medicine, Department of Population Health, 180 Madison Avenue 4-16, New York, NY, 10016, USA

^e Columbia University, Mailman School of Public Health, Department of Epidemiology, New York State Psychiatric Institute, Vagelos College of Physicians and Surgeons, Columbia University Irving Medical Center, Department of Psychiatry, 722 West 168th Street, Room 228F, New York, NY, 10032, USA

^f Columbia University, Mailman School of Public Health, Department of Epidemiology, 722 West 168th Street, 5th Floor, Room 509, New York, NY, 10032, United States

^g Columbia University, Mailman School of Public Health, Department of Epidemiology, 722 West 168th Street, Room 507, New York, NY, 10032, USA

^h Columbia University, Mailman School of Public Health, Department of Epidemiology, 722 West 168th Street, Room 724, New York, NY, 10032, USA

ARTICLE INFO

Keywords:

Depression
Time use
Self-esteem
Self-derogation

ABSTRACT

Introduction: Adolescent time use in recent cohorts is distinguished by large-scale changes, including shifts in parental monitoring, supervision, and adolescent activity patterns, that together may provide a more complete perspective on changing patterns of mental health than can be captured by single risk factors.

Methods: To determine whether patterns of adolescent time use explain recent increases in depressive and other internalizing symptoms, we first conducted latent profile analyses of 465,839 adolescents, grades 8/10, from annual, cross-sectional Monitoring the Future surveys, years:1991–2019, using twenty-one variables (e.g., frequency of attending parties) to identify groups based on patterns of time use. Most of the sample was female (51.0%), non-Hispanic white (58.8%), and in grade 8 (52.2%); mean age: 14.60 years (95% CI: 14.57, 14.64). We subsequently examined differences in depressive and other internalizing symptoms between these time use groups over time with survey-weighted logistic regressions producing odds ratios.

Results: Analyses derived six groups: part time workers, full time workers, and four groups based on levels of social activities (Low, medium, and high levels, with “High Social” split between those engaged in sports, academics, and community service and those who were not). Internalizing symptoms were predicted by lower socialization, low engagement in activities like sports, academics, and community service, and time spent at a paid job. Adolescents decreasingly engaged in social activities over time, though shifts in time use patterns did not account for much of the overall increase in depressive symptoms.

Conclusion: Shifts in adolescent time use do not explain increases in depressive and other internalizing symptoms, which increased across different patterns of time use. Levels of internalizing symptoms were highest among those with low socialization, low recreational engagement, and those working substantial hours. Encouraging socialization, engagement in recreational activities, and providing mental health resources for isolated adolescents may reduce internalizing symptom trends.

1. Introduction

Adolescent time use has experienced significant shifts over the past

few decades. Several milestones that coincide with early adolescence, such as working, dating, and going out without a parent, have declined consistently as these milestones have shifted towards later

* Corresponding author.

E-mail addresses: ntk2109@cumc.columbia.edu (N.T. Kreski), qc2138@cumc.columbia.edu (Q. Chen), Mark.Olfson@nyspi.columbia.edu (M. Olfson), Magdalena.Cerdá@nyulangone.org (M. Cerdá), dsh2@cumc.columbia.edu (D.S. Hasin), ssm2183@columbia.edu (S.S. Martins), pm2838@cumc.columbia.edu (P.M. Mauro), kmk2104@cumc.columbia.edu (K.M. Keyes).

<https://doi.org/10.1016/j.ssmph.2022.101181>

Received 24 January 2022; Received in revised form 18 July 2022; Accepted 19 July 2022

Available online 3 August 2022

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developmental periods, reflecting a slower overall path of development (Arnett, 2014; Twenge & Park, 2019). Consequently, not only have the ways in which adolescents spend their time changed, but at a larger level, the years encompassing adolescence have been extended in recent cohorts. This slowing of the developmental trajectory has widened the span between the initiation of adolescence and transition to later developmental stages (Crosnoe & Johnson, 2011). Thus, shifts in adolescent time use have a longer developmental window to impact adolescent mental health. Together, these patterns suggest that adolescent social development and its timing are fundamentally changing, yet the impact on population-level changes in adolescent mental health is uncertain.

One core context surrounding how adolescents spend their time is the extent to which their social behaviors are supervised or structured by a parent, caregiver or other adult. While independence and autonomy are often normative and beneficial to adolescent development (Zimmer-Gembeck & Collins, 2008), supervision and monitoring of adolescents during this period continue to have distinct mental health benefits (Hamza & Willoughby, 2011; Hoeve et al., 2009; Kaur et al., 2014; Miconi et al., 2019). Still, concerns surrounding too much parental supervision and structure (e.g., overscheduling) persist, and further research is needed to understand the ways in which various levels of structure and supervision shape the mental health outcomes of young people. Other work has aimed to link adolescent mental health and well-being to patterns of time use. However, this research typically focuses on quality of life, life satisfaction, or happiness (Ahn & Yoo, 2022; Martins et al., 2021; Wong et al., 2017), which are correlated with but may not be indicative of psychiatric symptoms. Still, these outcomes were higher among adolescents with high levels of engagement in certain activities, especially sports and academics, and socialization with peers. Studies that have focused on adolescent internalizing symptoms have demonstrated that too little or too much structure may be detrimental to adolescent mental health (Desha & Ziviani, 2007; Zuzanek, 2005), although more recent data are needed given the rapid increases in adolescent internalizing symptoms in the US since around 2010 (Keyes et al., 2019; Mojtabai et al., 2016).

Depressive and other internalizing symptoms have substantially increased among US adolescents over the past decade, but the factors driving this trend remain uncertain (Askari et al., 2021; Keyes et al., 2019; Lu, 2019). Existing research has focused on assessing individual risk factors that might explain the increase in internalizing symptoms, such as new social networking and media use patterns (Odgers & Jensen, 2020; Orben, 2020; Orben & Przybylski, 2019), decreased religious engagement (Kreski et al., 2021a), and bullying (Kreski et al., 2021b; Pontes et al., 2018). However, the ways in which adolescents use their time is complex, and models assessing single risk factors have thus far been unable to fully explain upward trends in depressive symptoms. This could either be due to risk factors not changing over time, or because changes in depressive symptoms have been driven by a combination of multiple factors, rather than any one risk factor in isolation. Examining broader patterns of how adolescents spend their time and engage in activities may identify risk patterns that elucidate trends in adolescent mental health. In sum, adolescent time use in recent cohorts is distinguished by large-scale societal changes, including shifts in parental monitoring, supervision, and adolescent activity patterns, that together may provide a more complete perspective on changing patterns of mental health than can be captured in studies of single risk factors.

This study (a) identified patterns of adolescent time use in a large, nationally-representative sample of adolescents; (b) examined the extent to which these patterns changed between 1991 and 2019; (c) estimated their relationships with mental health variables, including depressive symptoms, self-esteem and self-derogation; and (d) investigated whether changing patterns of adolescent time use explain trends in adolescent mental health. With this more comprehensive approach identifying potential risk factors for poor mental health among adolescents, a collaborative effort by health professionals, parents/caregivers,

and school staff can work to improve mental health across the diverse domains of an adolescent's life.

2. Methods

We utilized nationally representative, cross-sectional yearly samples of the Monitoring the Future (MTF) study (1991–2019, N = 465,839 adolescents in grades 8 and 10) (Miech et al., 2020). These data were collected via self-completed student surveys in schools. Schools were chosen with a multi-stage random sampling design. Schools that declined participation were replaced with schools that had similar geographic location, urbanicity and size. The survey included core questions asked of all students and subforms with specific content randomized to selected students. The MTF study was approved by the IRB of University of Michigan, which holds the data. Data were accessed and analyzed at Columbia University as part of an ongoing, IRB-approved secondary data analysis. The current study used adolescents assigned to two out of four subforms, chosen because they included mental health outcomes and a set of time use items. While MTF also surveyed students in grade 12, the overlap of time use items and mental health outcomes was minimal, and so grade 12 was excluded from this study. Student response rates ranged from 85% to 91% by year and grade, and the resulting data were weighted to reflect the general population of US school-attending adolescents in grades 8 and 10.

2.1. Measures

2.1.1. Time use

Twenty-one ordinal variables captured adolescent time use (ETable 1). Items were typically structured as, “How often do you do each of the following?” or having students answer the number of hours spent engaged in a specific activity per day or week with ordinal response options. Eight items covered activities within the domain of “Recreation”, including diverse modes of media consumption (e.g., listening to music) and hobbies (e.g., sports). Eight items covered activities within the domain of “Social/Unsupervised Time”, including activities that were done with the primary purpose of spending time with peers (e.g., dates, parties) or time without supervision (e.g., time after school alone). The remaining items covered activities that were academic (academic performance as a proxy for academic engagement and homework hours), community focused (community service and religious service attendance), and work focused (hours at a paid job). All items included were available in all decades, except social media use, which was included in MTF surveys beginning in 2009 and has persisted as a commonly hypothesized determinant of adolescent mental health (Keles et al., 2020). Full distributions of time use item responses are available in ETable 2.

2.1.2. Internalizing symptoms

The primary outcome was depressive symptoms. Four items were used to measure depressive symptoms, with responses ranging from 1 (Disagree) to 5 (Agree): “Life often seems meaningless”, “The future often seems hopeless”, “It feels good to be alive” reverse-coded, and “I enjoy life as much as anyone” reverse-coded (Cronbach's alpha = 0.78 within the study sample). This scale was derived from the Bentler Medical and Psychological Functioning Inventory's scale for depression personality trait and has been used as a measure of depressive symptoms in prior research (Coley et al., 2019; Maslowsky, Schulenberg, O'Malley, & Kloska, 2014; Maslowsky et al., 2014, 2014; Newcomb et al., 1981; Twenge et al., 2017). In adolescent samples, these items exhibit strong reliability (Newcomb et al., 1986). Total scores ranged from 4 to 20 (mean = 7.92 [95% CI: 7.89, 7.95]), indicating that the mean was close to “Mostly Disagree”. Respondents missing data on one item (2.3%) were imputed with the mean value of the other three; respondents missing data on 2 or more items (14.8%) were excluded from the analysis due to additional missingness across other items. A total of 397,

158 adolescents were included in depressive symptom analyses. Those who were excluded were more likely to be younger, male, and non-white than those who were included (proportion in grade 8 [excluded vs included]: 65.8% vs. 50.0%; proportion male [excluded vs. included]: 55.9% vs. 48.0%; proportion non-white [excluded vs. included]: 58.8% vs. 38.6%).

Additional scales measured self-esteem and self-derogation. Self-esteem was assessed with the following items: “I take a positive attitude toward myself”, “I feel I am a person of worth, on an equal plane with others”, “I am able to do things as well as most other people”, and “On the whole I am satisfied with myself” (Cronbach’s alpha = 0.83 within the study sample). Self-derogation was measured with the items “Sometimes I think that I am no good at all”, “I feel I do not have much to be proud of”, “I feel I can’t do anything right” and “I feel that my life is not very useful” (Cronbach’s alpha = 0.84 within the study sample). These two scales are largely adapted from the Rosenberg Self-Esteem Scale which examines positive and negative feelings about the self and was designed for adolescents (Rosenberg, 1965). These scales have been implemented similarly in other analyses of MTF data (Handren et al., 2016; Kaur et al., 2020). These scales are listed in ETable 3 and were included as sensitivity analyses. Binary outcomes were created for the highest decile of depressive symptoms (>13) given that the typical prevalence of past-year major depressive episodes among adolescents is around 10% (Mojtabai et al., 2016). As sensitivity and supplemental analyses, we also examined the highest quartile of depressive symptoms (>10) and self-derogation (>11), and the lowest quartile of self-esteem scores (≤14).

2.1.3. Covariates

Demographic covariates included sex (male/female), race and ethnicity (white, Black, Hispanic/Latino, Multiracial, or Other), grade (8th/10th), urbanicity (Metropolitan Statistical Area vs. not), highest level of parental education (<high school, high school or some college, college graduate), and school type (public, private Non-Catholic, private Catholic). Among those with covariate data, the majority of the overall sample (N = 465,839) was female (51.0%), non-Hispanic white (58.8%), in grade 8 (52.2%), lived in an MSA (77.7%), attended public school (92.0%), and had a parent who graduated college (53.7%). For additional demographic context, the sample had a mean age of 14.60 years (95% CI: 14.57, 14.64).

2.2. Statistical analysis

We used Latent Profile Analysis in Mplus (Asparouhov & Muthén, 2014; Vermunt, 2010) to identify groups of adolescents based on patterns of adolescent time use captured via the 21 time use variables described above. The number of groups extracted was based on the Bayesian Information Criterion (BIC), the Likelihood Ratio Test (LRT) for k vs k-1 groups, and interpretability (Masyn, 2013). Due to our large sample and the goal to identify meaningful groups of adolescents categorized by their time use, we balanced model fit indices, parsimony, and interpretability comparing up to seven groups, ultimately selecting a six group structure. This number of groups had the highest entropy value of any configuration tested (0.851). Entropy is an index in latent analyses where a higher number reflects higher precision in assigning individuals to latent groups.

We used the Vermunt three-step process to assign individuals to groups and predict outcomes: 1. Use the time use variables to identify the latent profiles of adolescent time use; 2. Determine the measurement error for the most likely profile variable, and lastly; 3. Estimate outcomes using the most likely group and the measurement error determined in step 2 (Asparouhov & Muthén, 2014; Vermunt, 2010). We examined the means, trends, and distributions of internalizing symptoms by time use group defined using the latent profile information with this measurement error. For logistic regression analyses, we used most likely (i.e., modal) time use group membership to define time use groups

without accounting for measurement error, as logistic regression analyses could not accommodate both the necessary survey weighting and latent profile uncertainty with a three-step approach due to limitations in Mplus options for complex modelling. The survey weighting in MTF data accounts for the complex survey design and respondent selection probabilities. All analyses accounted for the appropriate weight, strata, and cluster variables. Survey-weighted logistic regression analyses examined depressive symptoms and other outcomes by latent profile group and decade (1991–1999, 2000–2009, 2010–2019), adjusting for covariates (sex, race/ethnicity, grade, urbanicity, parental education, and school type). Covariate missingness ranged from 3.6% (sex) to 9.3% (parental education). For these regression analyses, covariates were imputed via multiple imputation by chained equations (k = 5 imputations).

Additional analyses examined the extent to which shifting patterns of time use explained trends in depressive symptoms and other outcomes. We estimated the projected trend in each symptom scale that would have occurred if time use patterns had stayed at 1991 levels. For example, the projected 2019 prevalence of high depressive symptoms was estimated by taking the group-specific symptom prevalence for each of the six time use groups in 2019 and multiplying these by each group’s 1991 prevalence, then summing together to see the prevalence of high depressive symptoms that would have occurred if time use groups had static prevalence since 1991. For the other outcomes, we instead used the mean scores by time use group and year weighted by each group’s 1991 prevalence and summed together.

3. Results

3.1. Time use groups

We identified six distinct groups of adolescents in grades 8 and 10 distinguished by their time use patterns (ETable 4). ETable 5 describes metrics used to describe model fit; BIC decreased with each additional group in this large sample but the reduction is small from the model with 6 groups to the model with 7 groups, and LRT suggested that 7 groups were not significantly superior to 6. Thus, we selected 6 groups to balance fit and interpretability. ETable 6 shows classification probabilities for most likely latent class membership by latent class, showing strong separation of classes.

Groups were named based on salient mean item responses (Fig. 1). Group 1 (Low Social, 8.4% prevalence across all years) had the lowest levels of unsupervised socializing activities including dates, parties, and time out without a parent. Group 2 (Medium Social, 31.7%) had a medium level of unsupervised socializing activities, as well as elevated levels of academic variables. Group 3 (High Social/Disengaged, 11.4%) was most notably the students who had high levels of unsupervised socializing activities, but low levels of sports, academic engagement, or community service. Group 4 (Part Time Workers, 12.3%) was marked by moderate levels of working a paid job, reporting between 6 and 20 h of paid employment per week. Group 5 (High Social/Engaged, 32.0%) was characterized by high levels of unsupervised socializing activities, such as dates, parties, and time out without a parent, as well as high levels of sports, academic engagement, and community service. Lastly, Group 6 (Full Time Workers, 4.3%) was defined by high levels of paid employment, from 21 to 30+ hours at a paid job weekly. It should be noted that groups 4 and 6, the Part Time and Full Time Worker groups, had levels of social activities (e.g., parties and social media) comparable to the high social groups, but were distinguished by their hours spent working.

Demographic characteristics for each of the 6 groups based on modal class assignment without measurement errors are reported in Table 1. The Medium Social group had the lowest public school attendance rate, highest prevalence of 8th grade students, highest prevalence of MSA residence and highest parental education. The High Social/Disengaged group had the highest prevalence of public school attendance, highest prevalence of female students, lowest prevalence of non-Hispanic white

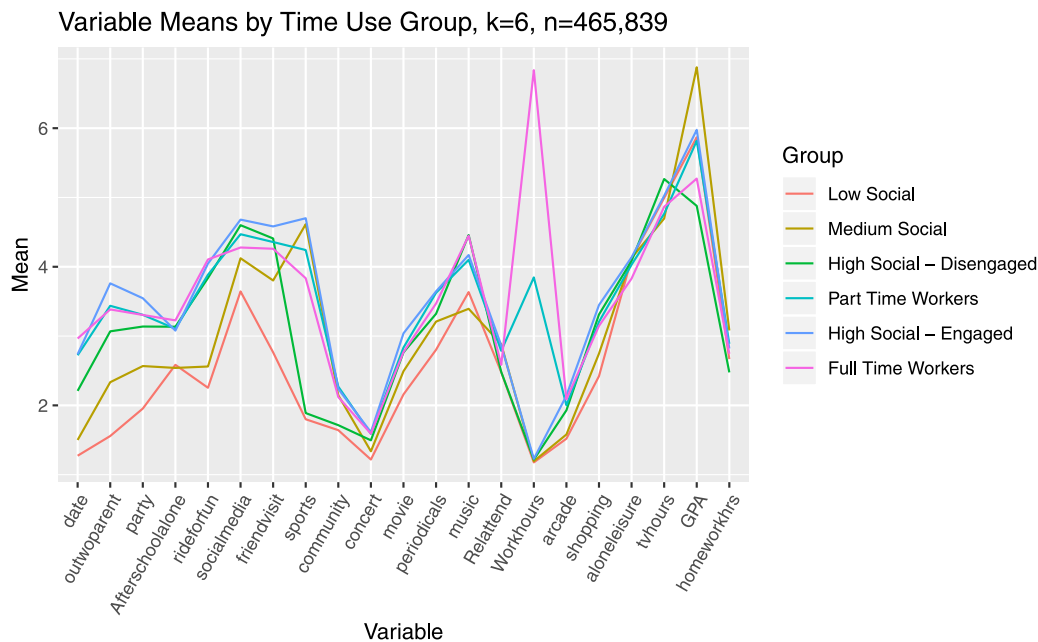


Fig. 1. Variable means by time use group, 1991–2019.

Table 1
Demographic characteristics* by time use group among US adolescents in grades 8 and 10, 1991–2019.

Characteristic (Sample Size n and percentages)	Group					
	1	2	3	4	5	6
	Low Social %	Medium Social %	High Social/ Disengaged %	Part Time Workers %	High Social/ Engaged %	Full Time Workers %
Sample Size (n)	(N = 38813)	(N = 146927)	(N = 53569)	(N = 56710)	(N = 150457)	(N = 19363)
Sample Proportion	8.4	31.7	11.4	12.3	32.0	4.3
School Type						
Public	95.2	88.7	96.4	93.2	92.0	96.2
Private Catholic	2.9	6.0	2.4	4.4	5.0	2.2
Private Non-Catholic	1.9	5.3	1.2	2.4	3.0	1.6
Sex						
Male	43.9	48.6	32.6	54.0	47.7	60.7
Female	52.1	48.4	63.5	42.8	48.7	34.9
Missing	4.0	3.0	3.8	3.2	3.6	4.4
Grade						
8	55.5	58.1	51.2	39.1	53.8	29.6
10	44.5	41.9	48.8	60.9	46.2	70.4
Race/Ethnicity						
White	48.3	60.5	47.0	65.1	55.3	54.3
Black	11.7	9.7	16.2	9.8	15.1	13.9
Hispanic/Latino	21.3	14.1	21.9	12.5	16.1	16.3
Multiracial	2.9	2.6	2.0	1.4	2.0	1.6
Other	11.6	9.9	8.6	7.7	7.5	9.2
Missing	4.3	3.2	4.3	3.5	4.0	4.8
Urbanicity						
Non-MSA**	24.2	20.7	23.4	25.6	21.2	27.1
MSA**	75.8	79.3	76.6	74.4	78.8	72.9
Parental Education						
Less than High School	11.8	5.3	13.0	7.1	6.4	11.0
High School Grad	34.3	29.1	41.4	38.4	35.1	41.4
College Grad	37.1	57.3	33.1	48.0	50.6	38.2
Missing	16.8	8.3	12.5	6.6	7.9	9.5
Age (Mean and 95% CI)	14.53 (14.49, 14.58)	14.41 (14.37, 14.45)	14.66 (14.62, 14.70)	14.96 (14.92, 14.99)	14.56 (14.52, 14.60)	15.35 (15.31, 15.39)

*All chi-squares comparing demographics by group significant, $p < .0001$; **MSA – Metropolitan Statistical Area.

students and lowest parental education. Part Time Workers had the highest prevalence of non-Hispanic white students, while Full Time Workers had the highest prevalence of male students, 10th grade students, and students living outside an MSA.

While the characteristics of time use groupings appeared to be invariant across decades (EFig. 1), the proportions of students in each of these six groups changed from 1991 to 2019 (Fig. 2). The Low (1991

prevalence: 5.2%; 2019: 15.4%) and Medium (1991 prevalence: 19.2%; 2019: 41.2%) Social groups increased in size across decades, while the High Social Groups (Disengaged 1991 prevalence: 12.9%; 2019: 8.4%; Engaged 1991 prevalence: 42.4%; 2019: 23.4%) decreased. Thus, the Low Social group nearly tripled in size over the study period and the Medium Social Group more than doubled, while the High Social groups lost over a third of their size. The working groups also showed declines

Table 2

Odds ratios (and 95% confidence intervals) for the relationship between time use group and highest decile depressive symptoms, 1991–2019 by decade, adjusted (demographics)^a.

Group	1991–1999	2000–2009	2010–2019	Overall	Interaction (Decade*Time Use Group)
High Social/Engaged	Ref	Ref	Ref	Ref	
Low Social	2.46 (2.25, 2.69)	3.18 (2.94, 3.44)	3.02 (2.82, 3.24)	3.03 (2.90, 3.17)	p < .0001
Medium Social	0.96 (0.89, 1.03)	1.04 (0.97, 1.11)	1.19 (1.12, 1.26)	1.12 (1.08, 1.16)	F(10, 4125.0) = 5.18
High Social/Disengaged	2.17 (2.03, 2.32)	2.33 (2.17, 2.50)	2.12 (1.97, 2.29)	2.21 (2.11, 2.30)	
Part Time Workers	1.27 (1.19, 1.36)	1.33 (1.22, 1.44)	1.24 (1.13, 1.36)	1.28 (1.22, 1.34)	
Full Time Workers	1.67 (1.51, 1.84)	1.81 (1.64, 2.01)	1.72 (1.49, 1.98)	1.72 (1.62, 1.83)	

^a Adjusted for several covariates related to demographic factors, including sex (binary male/female), race and ethnicity (White, Black, Hispanic/Latino, Multiracial, or Other), grade (8th or 10th), urbanicity (whether an adolescent resided in a Metropolitan Statistical Area), highest level of parental education (less than high school, high school graduate, college graduate), and school type (public, private Non-Catholic, private Catholic).

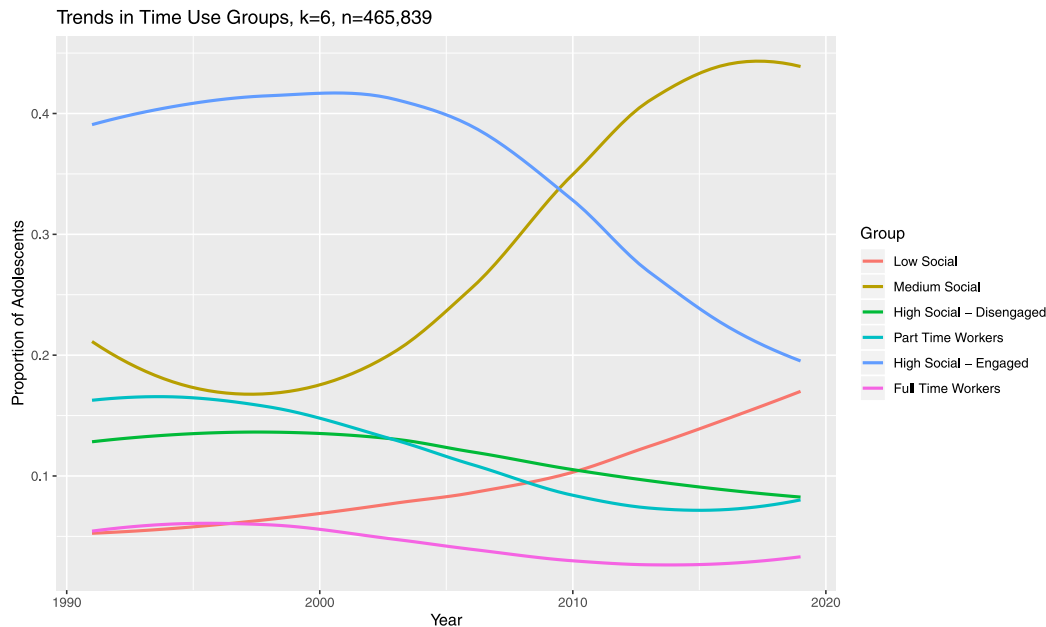


Fig. 2. Prevalence of time use groups among US adolescents with non-missing depressive symptom data by year, 1991–2019.

(Part Time Workers 1991 prevalence: 15.0%; 2019: 8.4%; Full Time Workers 1991 prevalence: 5.3%; 2019: 3.3%), similarly losing over a third of their initial size across the study years.

3.2. Depressive symptoms by time use group

The prevalence of high depressive symptoms increased over time in every latent profile group, especially since 2010. Differences in depressive symptoms persisted across time use groups, with the Medium Social and High Social/Engaged groups having the lowest symptoms, as seen in the smoothed trends of Fig. 3. For other internalizing symptom outcomes, patterns were similar, though marked by strong recent increases in mean internalizing symptoms for the medium social group and mostly stagnant trends for the High Social/Engaged group (EFigures 2, 3, 4).

After adjustment for demographic characteristics (Table 2), logistic regression models confirmed that depressive symptoms were, overall, lowest for those in the High Social/Engaged group, followed by the Medium Social group (aOR [Medium vs High Social/Engaged]: 1.12, 95% CI: 1.08, 1.16). Part Time and Full Time Worker groups had between one and two times the odds of high depressive symptoms compared to the High Social/Engaged group. The High Social/Disengaged group had distinctly elevated odds of high depressive symptoms compared to their more engaged peers (overall aOR vs High Social/Engaged: 2.21, 95% CI: 2.11, 2.30). The Low Social group had the

highest odds of all, with over three times the odds of this outcome compared to the reference group. There was heterogeneity by decade, but not with consistent trends in these shifts (p < .0001). Adjusted odds ratios grew stronger between 1991-1999 and 2000–2009 for the Low Social, High Social/Disengaged, Part Time Worker and Full Time Worker groups, but then declined for all these groups between 2000-2009 and 2010–2019. Associations for the Medium Social group consistently grew in magnitude across decades. In the sensitivity and supplemental analyses, group differences were similar for the highest quartile of depressive symptoms, self-derogation and low self-esteem, though for top quartile depressive symptoms and self-derogation, the Medium Social group had the lowest overall odds (ETable 7).

EFig. 5 shows the component contribution of each time use group to the prevalence of high depressive symptoms from 1991 to 2019. This figure mapped the prevalence of each time use group multiplied by the group-specific prevalence of high depressive symptoms in each year to understand how much the population prevalence is informed by any given group over time. By 2019, those in the Medium and Low Social groups contributed over 60% of adolescents with high depressive symptoms, which constitutes a historical shift seeing as the High Social – Engaged group had contributed most to this prevalence in 1991. Results were similar for the component contributions by time use group to the overall depressive symptom mean score (EFig. 6).

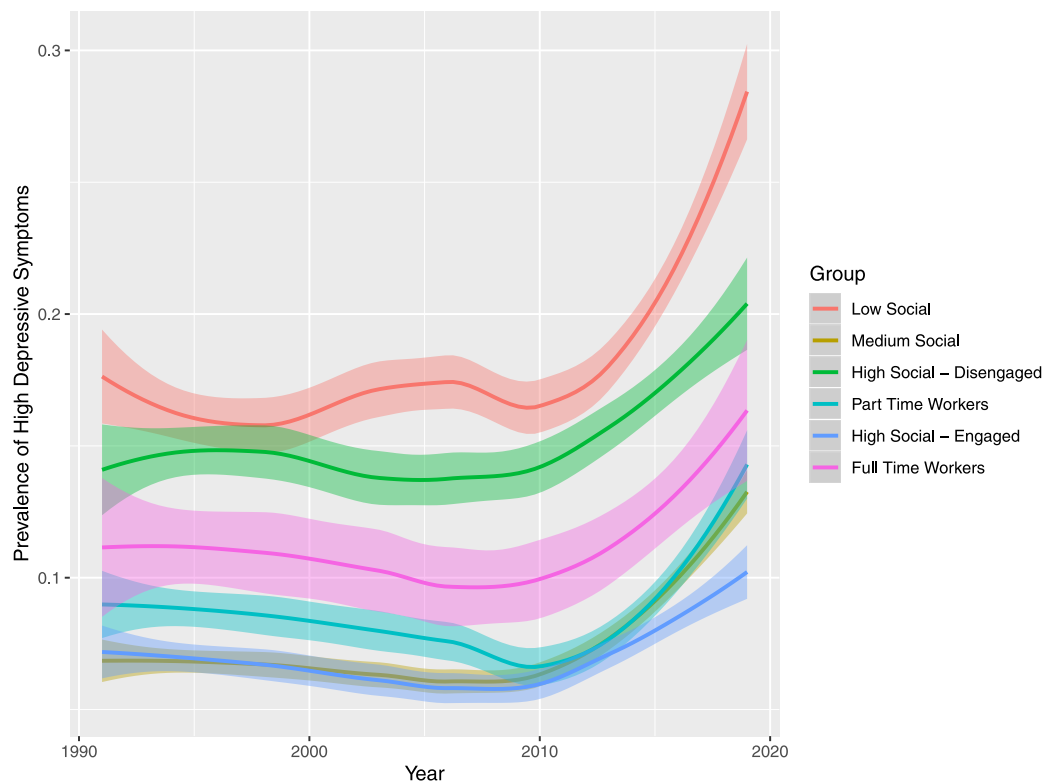


Fig. 3. Trends in high depressive symptom prevalence by time use group among US adolescents, 1991–2019.

3.3. Explaining trends in internalizing symptoms with time use

While the above analyses articulated differences and trends between individual groups, the distribution of time use groups from 1991 to 2019 and group-specific mental health outcomes each year allowed us to examine the extent to which mental health trends would have changed if patterns of time use had stayed at original 1991 levels. Applying this method, observed and projected trends in high depressive symptom prevalence were quite similar until recently. By 2019, however, a small portion of high depressive symptom prevalence was accounted for by shifting patterns of time use (Observed prevalence: 15.1%; Projected: 13.2%) (EFig. 7). Similar patterns of minimal, if any, explanation of trends existed for other internalizing symptom outcomes (EFigures 8, 9, 10). The similarity between observed and projected trends is the product of balance in the groups by prevalence and risk. While the High Social groups declined in prevalence, the two groups filling that gap are the Medium Social group, who had low depressive symptoms, and the Low Social group, whose depressive symptoms were higher than the High and Medium Social groups. Not only do differences in these groups essentially balance one another, but the trend in high depressive symptom prevalence has increased for every group over the past decade. In conclusion, shifts in the distribution of time use groups from 1991 to 2019 do not explain a large proportion of growing internalizing symptoms among US adolescents over time.

4. Discussion

From 1991 to 2019, unsupervised adolescent social activities, such as dates, parties, and time out without a parent, have rapidly declined. Adolescents with low levels of these forms of socialization had worse depressive symptoms than peers with moderate or high levels of social activities. For those with high levels of social activities, outcomes differed by other forms of engagement, specifically whether they were engaged in sports, academic endeavors, and community service.

Adolescents engaged in these pursuits fared better than others. Among adolescents whose time was primarily dedicated to paid employment, working a high number of hours was associated with higher internalizing symptoms than those working fewer hours. Shifting time use patterns among adolescents explained a small portion of the overall increase in high depressive symptoms in the US. All adolescents, regardless of time use, experienced increases in depressive and other internalizing symptoms. Given these universal increases in internalizing symptoms, our findings indicate that all adolescents need additional supports, even those historically considered lower risk.

Adolescents engaged in low social time had the highest internalizing symptoms of these groups defined by time use. In addition to fostering socialization in-person, similar connections can be fostered online; much available evidence indicates that screen-time is largely not harmful to adolescents and can be successfully leveraged for social connections (Odgers, 2018; Orben & Przybylski, 2019). Connecting adolescents to others with similar interests or identities in online spaces may foster the same emotional benefits received from similar connections made offline. Additionally, with the current coronavirus pandemic, digital social spaces remain safe venues for socialization even when in-person engagement may be risky. Students disengaged from social activities should receive particular attention moving forward to identify the specific experiences contributing to their elevated depressive symptoms and to develop interventions aimed at these adolescents. Alternatively, it may be that already depressed adolescents disengage from activities, social or otherwise, over time, so membership in these patterns of time use may be an outcome that signals the need to intervene against existing mental health issues by means outside of the activities that fall under “time use” as operationalized in this study.

Best practices for young people with internalizing symptoms include screening during their annual pediatric wellness visit, improved family and community support, sustained monitoring, ongoing communication with clinicians and care teams when symptoms are mild and a combination of evidence-supported (March et al., 2004) psychological therapy

(e.g., CBT) and antidepressants based on clinical evaluation and judgment when symptoms are more severe (Cheung et al., 2018; Zuckerbrot et al., 2018). Screening may also occur during other pediatric health appointments, or be conducted by school nurses and counselors. Additional focus toward a strong, accessible infrastructure for remote mental health treatment is necessary to ensure that mental health professionals are able to sustain their care even during the current pandemic (“Clinical Update: Telepsychiatry With Children and Adolescents,” 2017). Beyond these individual level practices, greater community efforts should be made to facilitate social connections and engaging activities for young people, plus workplace mental health resources for young people with jobs.

This work has a number of strengths. Examining time use groups and their mental health outcomes with the diverse set of items available in MTF provides a detailed portrait of the way that multiple domains of time use have changed across the last several decades, as well as how they are connected to internalizing symptoms among adolescents. Our large sample weighted to the adolescent population supports the generalizability of these findings to school-attending US adolescents. The strong separation of time use patterns ensures that the groups are distinct, and relevant to adolescent health. Still, this work has limitations. The depressive symptom scale was limited in domain coverage, lacking information on many physical, psychomotor, or neurovegetative symptoms, and we had no information on mental health treatment, though few adolescents receive this treatment (Hasin et al., 2005). Still, the scale exhibits strong reliability (0.72) in this population and covers core affective depressive symptoms (Newcomb et al., 1986). Regarding our time use items, no set of behavioral items can fully cover all the ways in which adolescents spend their time. Notably, it may be that in-person social experiences are being offset by digital interactions. Youth who have a significant level of online socialization but minimal in-person socialization with peers may be misclassified in our time use groups, registering as part of the “Low Social” group due to a lack of items on digital social connection.

Given the cross-sectional data in this study, we could not assess the temporal direction of associations between patterns of adolescent time use and mental health experiences. We also lacked context on certain components of time use, e.g., whether adolescents engaged in activities from their own desire to participate or because of external pressure. Similarly, adolescent time use and mental health are both closely tied to socioeconomic factors that could not be thoroughly explored in these data. This work utilized data from adolescents in the US in grades 8 and 10, and so may not apply to adolescents outside of the US, in different ages or grades, or adolescents not attending school. Additionally, those excluded from analyses due to data missingness were more likely to be younger, male, and non-white. While the reasons for non-response among these groups are unknown, this exclusion may potentially limit the extent to which these results apply to those demographic subgroups. Logistic analyses could not include the measurement error described in the three step Vermunt process (Vermunt, 2010); with the strong separation of classes, we expect the potential for this to bias results significantly to be minimal. While the time use items are ordinal, latent class analyses treating these items categorically were prohibitively intensive computationally. Latent profile analyses examining mean responses still yielded clearly separated, meaningful time use groups whose individual time use behavior item responses were often categorically distinct.

Adolescents, regardless of how they spend their time, are facing increased risk of internalizing symptoms. While patterns of adolescent time use have changed since 1991, recent shifts in these patterns only explain a small portion of the increase in US adolescent internalizing symptoms. Still, monitoring and addressing patterns of behavior that may lead to elevated mental health risks, such as minimal socialization, may be useful. A sustained focus on examining underlying patterns of adolescent time use can provide nuanced insights into adolescent mental health.

Funding statement

These analyses are funded by grant R01DA048853 (PI: Keyes) and with support from the Columbia Center for Injury Science and Prevention (R49-CE003094). Dr. Mauro reports funding from grant K01DA045224. Additionally, Dr. Martins reports funding from grant R01DA037866, and Dr. Hasin reports funding from grant R01DA048860. These funders had no role in the design or conduct of this study.

Ethics Approval Statement

The Institutional Review Boards of University of Michigan and Columbia University approved the study protocol and analytic aims respectively in compliance with ethical standards.

Patient consent statement

Respondent consent was addressed in compliance with IRB-approved study protocols.

Permission to reproduce material from other sources

N/A.

Clinical trial registration

N/A.

Ethical statement

Ethics Approval Statement: The Institutional Review Boards of University of Michigan and Columbia University approved the study protocol and analytic aims respectively in compliance with ethical standards.

Declaration of competing interest

None.

Data availability

The authors do not have permission to share data.

Acknowledgements

Kreski and Keyes conceptualized the study, designed and conducted the analyses, and produced initial manuscript text. All remaining authors contributed substantially to the conceptualizing and interpretation of this study and its results, and provided major revisions and additions to this text. Authors have no conflicts of interest to disclose. These analyses are funded by grant R01DA048853 (PI: Keyes) and with support from the Columbia Center for Injury Science and Prevention (R49-CE003094). Dr. Mauro reports funding from grant K01DA045224. Additionally, Dr. Martins reports funding from grant R01DA037866, and Dr. Hasin reports funding from grant R01DA048860. These funders had no role in the design or conduct of this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2022.101181>.

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