What underlying features of children's time use are related to depressive symptoms? Study Design

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ABSTRACT

This study examined three underlying dimensions of children's activity participation which are hypothesized to influence the emergence of depressive symptoms. These dimensions include the extent to which daily participation meets recommended levels of physical activity, the degree to which it involves structured activity, and its facilitation of socialization through engagement with parents, siblings/peers, and others. Time diary data from a nationally representative data set, the Panel Study of Income Dynamics Child Development Supplement II (CDS II) was analysed to highlight these dimensions of time use during early adolescence (children aged 12-13 years). The diaries documented each activity engaged in over two 24 hour periods, and with whom it was undertaken. Level of physical activity (weekend and weekday energy exertion) were extrapolated from this data using the exercise intensity values (METs) from the adult Compendium of Physical Activities (Ainsworth et.al., 2000). These values were adjusted to account for variation due to each child's age, sex and body mass index (BMI) (Harrell et.al., 2005). The degree of structured activity participation was quantified according to the recommendations of experts in child development, whose opinions were gathered in a modified group Delphi panel meeting. Opportunities for socialization with parents, peers/friends and others were determined from parents' and children's reports of social engagement during the time period recorded in the diaries. A structural equation model is proposed to explain possible causal mechanisms for the development of depression, based on data accessible in CDS II. The model incorporates all three identified dimensions of time use, and also contains key family factors which are widely acknowledged as being linked with both childhood depression and time use, including: child physical health, maternal psychosocial wellbeing (Birmaher et al., 1996; Kovacs et al., 1997), family conflict (McCauley and Myers, 1992), and socioeconomic status.

BACKGROUND

Children's involvement in everyday activities exposes them to myriad learning opportunities and socialization contexts. Their use of time may thereby provide opportunities for, or constrain, psychological and social development (Larson and Verma, 1999). Depression during childhood or adolescence is a common disorder (Angold and Costello, 1993), associated with significant morbidity and mortality (Birmaher et. al., 1996). It can have devastating effects on daily functioning (Weller and Weller, 2000), and confers a heightened risk for suicidal behaviour (Sawyer et. al., 2001). The possibility of adverse consequences provides an imperative to further investigate trajectories to childhood depression, and determine those factors which can be influenced to prevent its emergence. In order to enhance understanding of the complex contribution of children's time use to symptoms of depression, it is necessary to look beyond analysis of the simple distribution of time, to examine those underlying features of activity engagement which may be potentially beneficial or detrimental to psychosocial health.

In this study, three dimensions of children's activity engagement, relating to both content and context, which have been linked with depression were further explored. They include a) the degree to which activities provide energy expenditure, b) the extent to which activities constitute structured or unstructured time use, and c) whether activity participation promotes socialization through contact with parents, siblings/peers and others.

The object of this study was to quantify these dimensions of activity engagement to create three variables which reflect time engaged in physical activity, structured time, and social engagement. By defining and quantifying these variables, the study has facilitated future testing of their links with mental health outcomes using the CDS II data.

METHOD
Sample
Data were drawn from the nationally representative Panel Study of Income Dynamics Child Development Supplements II (CDS II). Information used in this study was gathered for CDS II in 2002/2003 by face-to-face or telephone interviews with primary care givers, direct child assessments (e.g. measurement of weight), and two 24 hour time diaries.

Children aged 12/13 during CDS II data collection were eligible for inclusion in this study (n=377). Of these, 9 children were excluded from analysis as they did not have two complete time diaries, leaving a sample of 368 children (184 boys, 184 girls). As parents were asked to rate how typical each diary day was on a 5 point likert scale (where 1 = very typical, 5= not at all typical), weekday or weekend diary data was excluded from some analyses if the day was assigned a score of greater than 3.

Procedure
Two diaries were mailed to participants in CDS II with instructions for their completion on a randomly assigned weekday and weekend day. They were filled out by children, with the support of parents where necessary. On the occasion of the telephone or face-to-face primary care giver interview the diaries were reviewed and edited to ensure their accurate completion. Diaries contained detailed information regarding the specific activity engaged in, and the social context in which it occurred. This information was used to calculate weekday and weekend energy expenditure, and time engaged with parents/siblings or peers/others. The diaries did not, however, contain any information regarding which activities could be justifiably labeled as 'structured' or 'unstructured'. The manner in which energy expenditure, socialization and level of structured activity participation were quantified is outlined below:

Energy Expenditure Calculations
Each activity coded in the CDS II was assigned an energy intensity rating, known as a 'MET'. One MET is the energy expenditure of sitting quietly and is equivalent to oxygen uptake of 1 $kcal.kg^{-1}.hr^{-1}$ (Ainsworth et al., 1993). MET values were drawn from the adult Compendium of Physical Activities (Ainsworth et al., 2000). In instances where there was no direct activity equivalent in the Compendium (e.g. 'playing computer games including solitaire') the MET value for a similar activity was substituted (e.g. 'sitting – card playing, playing board games'). When the CDS II activity codes (e.g. tennis lessons) had multiple similar activities listed in the Compendium (e.g. singles, doubles), the MET value for an activity listed as a 'general' estimate was adopted (i.e. 'tennis, general'). When the CDS II activity category included multiple types of activity (e.g. 'washing, showering, bathing'), the average MET from all relevant Compendium codes was assigned (e.g. 'showering or toweling off (standing)', 'bathing (sitting)', etc). Activity duration in each CDS II category was then multiplied by its assigned activity intensity (MET) and summed to give an indication of daily physical activity levels. As energy expenditure per kilogram of body mass is greater in children that adults, and varies according to puberty status, age adjusted energy expenditure values recommended by Harrell and colleagues (2005) were used to convert physical activity levels to an estimate of daily energy expenditure with the following formula: (child weight)kg x (age adjusted energy expenditure value relevant to child's age and sex) $kcal.kg^{-1}.hr^{-1}$x ($\sum$(MET x duration)) MET.hr (resulting in number of kilocalories per day ($kcal.d^{-1}$).

Socialization
The time diaries were designed to capture detailed information regarding the social context of activity participation. Participants recorded with whom they engaged in each activity, and who else was present at the time. This study focuses on time spent solely engaged with parents (including step parents), time solely engaged with siblings or peers, and time solely engaged with others (i.e., grandparents, other relatives or non-relatives). Where time was spent with a combination of these groups (e.g., 1 hour of joint interaction with one parent and a sibling), the duration of time was divided equally between the groups (e.g. 0.5 hours with 'parents' and 0.5 hours with 'siblings or peers') to ensure total time did not exceed 24 hours per weekend day or weekday.

Level of Structured Activity Participation
While there is no objective, published system for determining the degree to which common childhood activities are 'structured', the features of *leisure* activities which result in them being described as 'highly structured' include: being goal directed, involving adult participation or supervision, having routine or regular participation schedules, and emphasizing skill (Mahoney and Stattin, 2000). For the purpose of this study, a modified group Delphi process was adopted to rate CDS II activity codes according to the degree to which each activity is structured when engaged in by typically developing children in the USA. Delphi is an iterative process which provides an opportunity for experts to communicate their opinions about a problem and to see how their perspectives align with others (Powell Kennedy, 2003). It involves a series of questionnaires which are interspersed by controlled feedback. This allows participants to change their opinions about the problem after re-considering the findings of the group. The Delphi process seeks to gain a reliable consensus of opinion (Powell, 2002). The modified group Delphi process differs from traditional Delphi in that it is not conducted anonymously, and takes place during a single intensive meeting (Webler, Levine, Rakel and Renn,1991).

Following receipt of ethical approval from the appropriate Institutional Review Boards, participants were recruited for a single 1 ½ hour long panel meeting. Ten professionals attended (teachers and allied health professionals), who were experts in child development, with considerable years of experience working with children (M=23.8, SD=8.9). After a brief discussion

regarding the characteristics of a highly structured activities outlined in the literature (Mahoney and Stattin, 2000), participants were divided into two groups of 5. Each group was issued separate halves of a condensed list of the activities coded in the CDS II. The condensed list contained 202 activities. Some CDS codes were excluded due to them not being relevant to this age group (e.g. military service), others were collapsed into one activity due to their high level of similarity (e.g. all codes referring to traveling). Teams were instructed to come to group consensus, where possible, to rate each activity on a 5 point Likert scale, ranging from 1 (not at all structured) to 5 (completely structured). The lists were then swapped between the groups in order to inspect the other team's list and corresponding ratings. Participants were asked to record if they disagreed with any of the ratings and to offer an alternative rating where this occurred. Participants were then re-shuffled between groups and lists were randomly assigned to each new team. Participants were again instructed to come to group consensus, where possible, on the previously disputed activity ratings.

Results

Energy Expenditure

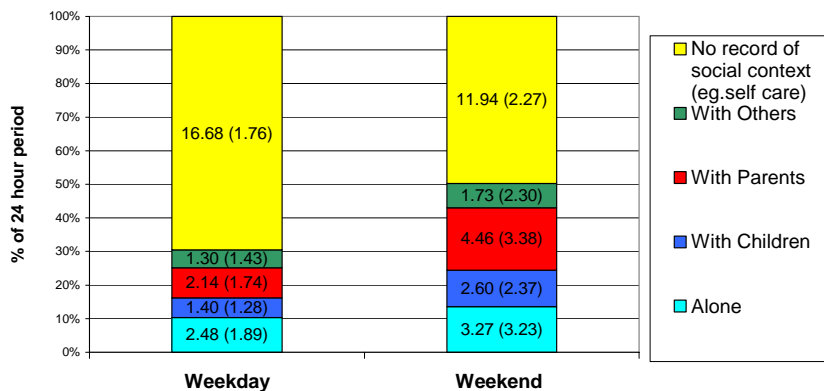|	Mon	Tues	Wed	Thu	Fri	Weekday	Sat	Sun	Weekend
N	72	66	73	66	69	346[#]	174	172	346[#]
Minimum	1214	1511	1661	1652	1204	1204	845	1242	845
Maximum	5733	5582	25336	6848	7417	25336	11341	24233	24235
Mean	2838	2850	3433	3062	3059	3051	3110	3064	3087
SD	893	884	3503	1085	1160	1846	1415	2364	1943

Table 1: Energy Expenditure on Weekdays and Weekend –days (kcal.d^{-1})
Energy Expenditure could not be calculated for 22 children due to missing data for weight.

Socialization
Figure 1illustrartes time spent in different social contexts. (No record of social context was made when children were engaged in personal care activities).

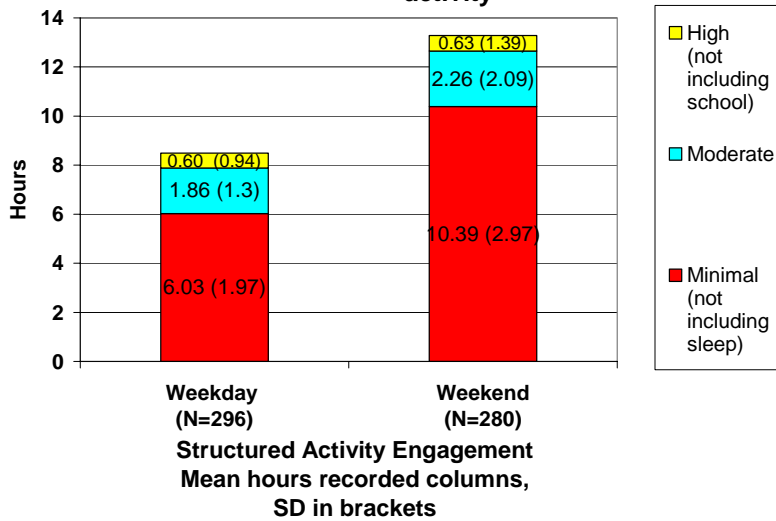Figure 1: Time Spent in Different Social Contexts

Weekday (N=296) vs Weekend (N=280)
Mean hours recorded on columns, SD in brackets

Structured Activity Participation
Of the 202 activities listed for the modified group Delphi process, teams initially disagreed collectively on 53 ratings. Following 2 rounds of ratings, consensus was achieved on 199 (99%) of all activities. On the three items, for which consensus was not achieved, for the purpose of this study the lower of the disputed ratings was assigned to the activity. Figure 2 displays the number of hours spent in minimally (ratings of 1 or 2), moderately (rating of 3) or highly (rating of 4 or 5) structured activities. Time devoted to sleeping (rating 1) or school (rating 5) is excluded from the graph.

Figure 2: Time spent in different levels of structured activity

Structured Activity Engagement
Mean hours recorded columns,
SD in brackets

DISCUSSION

This study has generated variables from the CDS II data which will allow simultaneous examination of their contribution to the emergence of depressive symptoms. The study has also highlighted preliminary evidence of key differences between weekday and weekend time use which need to be considered in future analysis. Structural Equation Modeling has the capacity to investigate such complex relationships. Through structural equation modeling, the influence of time use variables can be estimated while accounting for the effect of other well established risk factors for child-onset depression (including parental psychopathology, socioeconomic status and family conflict). A Structural Equation Model has been proposed (Figure 3), which also acknowledges the effect these factors on time use itself. The latent variables and their respective indicators are listed in table 2.
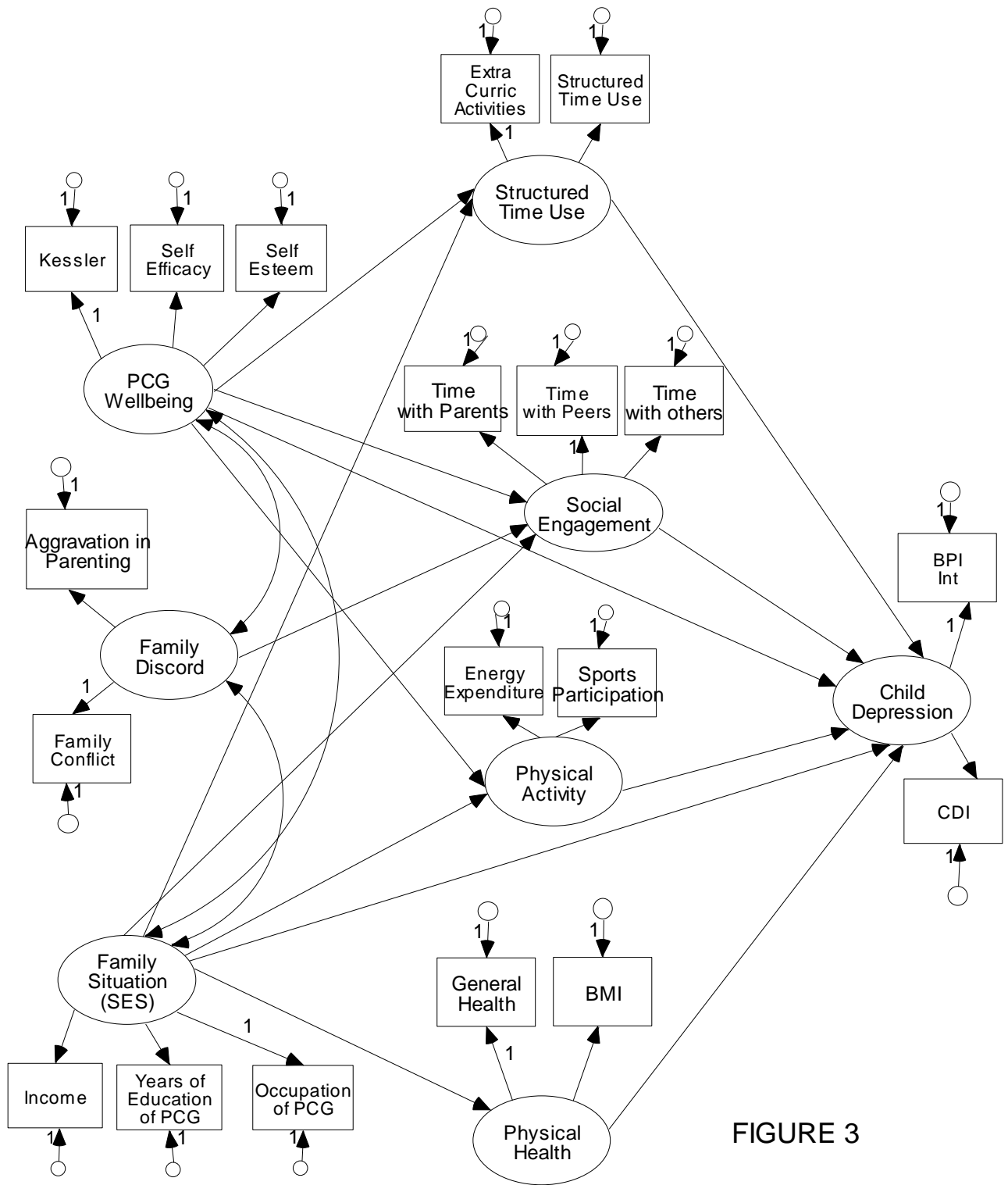
FIGURE 3

Table 2: Description of Structural Equation Model Latent Variables and their indicators.

Latent Variable	Indictors
Parent Wellbeing	• Scores on the Kessler 6 (Kessler et al., 2002) which measures non-specific distress. • Rosenberg Self Esteem Scale (Rosenberg, 1986) • Pearlin Self-Efficacy Scale (Pearlin, Lieberman, Menaghan and Mullan, 1981).
Family socioeconomic status	• Combined income of primary and secondary caregivers • Occupation of primary caregiver • Educational level (years of schooling) of the primary care giver.
Family Conflict	• Aggravation in Parenting Scale • Family Conflict Scales (Sweet, Bumpus and Call, 1988)
Child Depression	• Scores on the internalizing subscale of the Behavior Problems Index (BPI) (Peterson and Zill, 1986) • Childhood Depression Inventory (CDI) (Kovacs, 1981).
Social engagement	• Duration of time from weekday and weekend diary spent engaged with parents, engaged with peers and engaged with others.
Structured time use:	• Duration of time devoted to activities deemed to be minimally, moderately or highly structured. • Number of extracurricular activities (school or community) engaged in over the preceding 12 months.
Physical Wellbeing	• Body Mass Index • Primary caregiver's response to a single question asking for a rating of the child's global health (1-5)
Physical Activity levels: Assessed using and an estimate of	• Each child's weekday and weekend daily energy expenditure values • The number of sporting groups the child has participated in over the preceding 12 month period.

It is anticipated that adoption of a Structural Equation Modeling approach will shed light on the complex causal pathways to depressive disorders, and may give insights into the dimensions of daily activity involvement which should be targeted in early intervention programs.

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