Multiple health risk behaviors and mental health from a life course perspective

Wijbenga, Lisette; de Winter, Andrea F; Almansa, Josue; Vollebergh, Wilma A M; Korevaar, Eliza L; Hofstra, Jacomijn; Reijneveld, Sijmen A

Published in:
Preventive Medicine

DOI:
10.1016/j.ypmed.2021.106870

Preventive Medicine 154 (2022) 106870

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Multiple health risk behaviors and mental health from a life course perspective: The Dutch TRAILS study

Lisette Wijbenga [a,b,*], Andrea F. de Winter [a], Josue Almansa [a], Wilma A.M. Vollebergh [c], Eliza L. Korevaar [b], Jacomijn Hofstra [b], Sijmen A. Reijneveld [a]

[a] Department of Health Sciences, University of Groningen. University Medical Center Groningen, Groningen, The Netherlands
[b] Research and Innovation Center for Rehabilitation, Hanze University of Applied Sciences, Groningen, The Netherlands
[c] Department of Interdisciplinary Social Science, Utrecht University, Padualaan 14, Room A2.30, 3584 CH Utrecht, The Netherlands

ARTICLE INFO

Keywords:
Adolescence
Young adulthood
Multiple health risk behaviors
Life course
Mental health

ABSTRACT

We examined trajectories of multiple health risk behavior (MHRB) patterns throughout adolescence, and changes in mental health from childhood to young adulthood. Further, we assessed how continuity or onset of MHRBs overall were associated with subsequent changes in mental health, and whether this varied by type of MHRBs.

We used six waves of the prospective Dutch TRAILS study (2001–2016; n = 2229), covering ages 11 until 23. We measured MHRBs (substance use: alcohol misuse, cannabis use, smoking; and obesity-related: overweight, physical inactivity, irregular breakfast intake) at three time points during adolescence. We assessed mental health as Youth/Adult Self-report total problems at ages 11 and 23. Latent class growth analyses and ANOVA were used to examine longitudinal trajectories and associations.

We identified six developmental trajectories for the total of MHRBs and mental health. Trajectories varied regarding likelihood of MHRBs throughout adolescence, mental health at baseline, and changes in mental health problems in young adulthood. We found no associations for the continuity of overall MHRBs throughout adolescence, and neither for early, mid- or late onset, with changes in mental health problems in young adulthood. However, continuity of MHRBs in the obesity-related subgroup was significantly associated with an increase in mental health problems.

Adolescents with the same MHRB patterns may, when reaching adulthood, have different levels of mental health problems, with mental health at age 11 being an important predictor. Further, involvement with obesity-related MHRBs continuously throughout adolescence is associated with increased mental health problems in young adulthood.

1. Introduction

Health risk behaviors, such as smoking, drug use, alcohol consumption, physical inactivity, irregular meals, and obesity, often accumulate during adolescence and are relatively persistent throughout the life course (de Winter et al., 2016; Klein Velderman et al., 2014; Mistry et al., 2009; van Nieuwenhuijzen et al., 2009). Numerous adolescents do not meet national guidelines for this spectrum of health behaviors which pose a risk for health problems later in life (de Winter et al., 2016; Rosenbaum Asarnow, 2014; van Nieuwenhuijzen et al., 2009). Prior research within the TRAILS study has shown an increase in prevalence rates of Multiple Health Risk Behaviors (MHRBs) of almost 7% among Dutch adolescents, all having more than five MHRBs from age 13 to 16, i.e. between 2003 and 2007 (de Winter et al., 2016). Given that MHRBs developed in adolescence are associated with changes in mental health outcomes over time (Yu et al., 2017), study of the life course should provide a better understanding of this issue.

Despite growing interest in MHRBs, few studies have investigated the link between MHRB patterns and long-term mental health problems. Heikkala et al. (2014) showed that smoking, physical inactivity, and

Abbreviations: HRBs, Health Risk Behaviors; MHRBs, Multiple Health Risk Behaviors; LCGA, Latent Class Growth Analyses; ANOVA, ANalyses Of Variance.

* Corresponding author at: Department of Health Sciences, University Medical Center Groningen, Antonius Deusinglaan 1, FA10, 9713 AV Groningen, The Netherlands.

E-mail addresses: l.wijbenga@umcg.nl (L. Wijbenga), j.almansa.ortiz@umcg.nl (J. Almansa), W.A.M.Vollebergh@uu.nl (W.A.M. Vollebergh), e.l.korevaar@pl.hanze.nl (E.L. Korevaar), j.hofstra@pl.hanze.nl (J. Hofstra), s.a.reijneveld@umcg.nl (S.A. Reijneveld).

https://doi.org/10.1016/j.ypmed.2021.106870
Received 5 March 2021; Received in revised form 20 October 2021; Accepted 4 November 2021
Available online 12 November 2021

high BMI were associated with psychosocial problems among adolescents aged 16–18. Another recent study indicated a link between MHRBs in late adolescence and depressive symptoms in young adulthood (Yu et al., 2017). Nevertheless, studies from a life course perspective with more than two time points are scarce, especially research that links the accumulation of health risk behaviors (HRBs) in adolescence to mental health problems in young adulthood. However, the *accumulation of risk* hypothesis suggests that exposure to MHRBs may lead to long-term health disadvantages (Kuh et al., 2003). We define accumulation of risk, or MHRBs, in line with the clustering approach posed by McAloney et al. (2013), which assumes that concurrent health risk behaviors are associated over time (de Winter et al., 2016) and do not 'co-occur' independently (McAloney et al., 2013).

In addition to the accumulation of risk, an early onset of MHRBs is also likely to affect a person's level of mental health problems. However, such associations have been established mainly for single risk behaviors. For example, one study showed an initiation of alcohol misuse in early adolescence to be associated with higher levels of depression (Skogen et al., 2016). Another study on substance use indicated that early adolescence was a particularly vulnerable period, and that trajectories with an early onset of substance use were associated with poorer mental health outcomes (Tucker et al., 2005). From a life course perspective, the *critical period hypothesis* suggests that the timing of exposure may be linked to irreversible changes in long-term health (Kuh et al., 2003).

Effects of MHRBs on mental health may vary in relation to specific HRBs. Although using a broader range, van Nieuwenhuijzen et al. (2009) found that clustering of MHRBs occurs at different ages, with different types of interrelated subgroups. Examples were a cluster of behaviors related to substance use, and another cluster related to health, such as breakfast and exercise behaviors (Dusseldorp et al., 2014; Klein Velderman et al., 2014; van Nieuwenhuijzen et al., 2009). The present study therefore separately investigated the effects of substance use and obesity-related MHRBs on changes in mental health in young adulthood. Insights into associations between total MHRBs and young adult's mental health, as well as comparison of the subgroups, will be useful for improvement of current interventions, since the majority of research and interventions still focus on single risk behaviors (Hale et al., 2014).

This study aims to obtain more insight into trajectories of multiple health risk behavior (MHRB) patterns throughout adolescence, and changes in mental health from childhood to young adulthood. It further assesses how the continuity or onset of MHRBs were associated with changes in mental health. All analyses were conducted for overall MHRBs, as well as for two subgroups: substance use and obesity-related MHRBs.

2. Methods

2.1. Sample

This study used data from the first six waves (T1–T6, ages 11–23) of the Tracking Adolescents' Individual Lives Survey (TRAILS) study, an ongoing prospective cohort study on early adolescents living in the north of The Netherlands, both rural and urban areas (Oldehinkel et al., 2015). The sample is representative for the north of The Netherlands. More information on the sample selection can be found elsewhere (De Winter et al., 2005; Huisman et al., 2008; Oldehinkel et al., 2006). In the first wave (T1, 2001–2002) 2229 adolescents were included (response rate 76%; mean age = 11.1; SD = 0.6). As 86 individuals did not score on any of the MHRB questionnaires, they were omitted.

2.2. Procedure

In the first wave (T1) we interviewed parents or caretakers (preferably the mother, 95.6%) at their homes, on a wide range of topics. They also filled out several questionnaires. Under supervision by TRAILS assistants, the adolescents filled out questionnaires at school or other testing locations. From all adolescents and their parents or caretakers we obtained written informed consent. The Dutch Central Committee on Research involving Human Subjects approved each of the six waves of the TRAILS study. More details concerning the TRAILS study are available elsewhere (Oldehinkel et al., 2015).

2.3. Measures

2.3.1. Multiple health risk behaviors

We included six health risk behaviors (HRBs), measured similarly in T2, T3, and T4. The validity of these measurements has been well documented (Klein Velderman et al., 2014; van Nieuwenhuijzen et al., 2009). To create the sum variable of MHRBs, we dichotomized each HRB (presence vs. absence of HRB). All classifications took place in accordance with national guidelines. Aside from the overall MHRBs we defined two subgroups, each compromising three HRBs: substance use (alcohol, smoking, cannabis), and obesity-related lifestyle (breakfast, overweight, physical inactivity). We were interested in dividing the adolescents who most certainly engaged in MHRBs and those who did not. Due to this and the rather large amount of HRBs used, we used a cutoff score of three HRBs or more per wave (T2–T4), to identify those most strongly engaged (Freyer-Adam et al., 2011). For the subgroups we used a cutoff score of one HRB or more per wave (T2–T4), indicating the presence of at least one HRB within that category. We constructed MHRB patterns using dichotomized representations of the presence of MHRBs per wave (T2–T4), creating string patterns of three binary codes to indicate the presence of MHRBs per wave ('1'), the absence of MHRBs ('0'), or either value ('*') at wave T2, T3 or T4. We examined prolonged MHRB patterns regarding the continuity of MHRBs at T2–T4 ('111'), as well as all early onset patterns with MHRBs at T2 ('1**'), all mid-onset patterns with MHRBs at T3 ('01*'), and late onset MHRB patterns with MHRBs at T4 ('001'). We measured each single HRB as described below.

Alcohol: We asked adolescents how many alcoholic beverages they had drunk weekly in the last 12 months. Under Dutch law, at the time of this study adolescents aged 16 and older were allowed to drink alcohol. For these adolescents of legal age to drink alcohol we created a cutoff score based on guidelines for adults; which indicated: no more than one drink per day (Gezondheidsraad, 2015). *Smoking:* This was defined as smoking one or more cigarettes per day. We assessed smoking by asking adolescents whether they had ever smoked. Five categories were indicated, ranging from "I never smoked" to "I smoke every day". If participants indicated they had only a few puffs or one cigarette, they were considered to have smoked. However, "I never smoked" and "I have smoked in the past, but I have stopped completely" were categorized as non-smoking. *Cannabis:* This was defined as any use of cannabis in the past 12 months. Participants were asked how many times they used cannabis in this period. *No regular breakfast:* This was defined as consuming breakfast on fewer than 5 days a week. *Overweight:* To asses overweight or obesity, we calculated body mass index (BMI) using measurements of weight and height. For this purpose, TRAILS used regularly calibrated equipment (respectively, models 770 and 214; in kg and m^2; Seca, Hamburg, Germany). Cutoff scores of overweight and obesity (i.e. 25 kg/m2) were in agreement with international WHO age- and gender-adjusted BMI criteria (Bentham et al., 2017; Cole et al., 2000). *Physical inactivity:* We determined this by using the Short QUestionnaire to ASsess Health-enhancing physical activity (SQUASH), with various questions about activities such as sports. We quantified physical activity using the Metabolic Equivalent of Tasks (METs). To measure the recommended level of physical activity we used a cutoff score of 7 days a week, 60 min a day (METs $\geq$ 3)(Haskell et al., 2007).

2.3.2. Mental health

We assessed mental health problems at T1 using the Youth Self Report (YSR), and at T5 and T6 using the Adult Self Report (ASR). Both the YSR and the ASR are highly valid and reliable measurements (Achenbach and Rescorla, 2003, 2001). Participants answered 112 items

on behavioral and emotional problems within a time frame of 6 months, on a three-point scale (*not true, somewhat or sometimes true, very true* or *often true*). We measured internalizing problems (*withdrawn/depressed, physical complaints,* and *anxious/depressed*), externalizing problems (*aggressive behavior, delinquent,* and *intrusive behavior*), and other mental problems (*thinking problems* and *attention problems*), and combined these into a total score. We used age-standardized scores of all scales combined, at a continuous level. Our outcome measure was a constructed mean variable of young adults' mental health problems at wave 5 and wave 6, with a score of 0 to a maximum of 1.23. Higher scores indicate more mental health problems. Scores above the 93th percentile were considered in the borderline and clinical range of mental health problems (Achenbach and Rescorla, 2003).

2.3.3. Background characteristics

At baseline, participants provided data on age, sex, ethnicity, and socioeconomic status. The latter was based on a combination of occupation and education of both mother and father, and family income.

2.4. Statistical analyses

Data with complete cases would reduce the sample by more than half (see Supplementary Table D), which could affect the validity of results and the statistical power (Graham, 2009; Little et al., 2012; White et al., 2011). Therefore, we created twenty imputed data-sets, which led to adequate estimates (White et al., 2011). Repetition of the analyses on only complete cases yielded findings with a similar direction, although final solutions differed due to the much lower power. Missing values were imputed for each of the six HRBs (T2–T4), using logistic regression, and for mental health scores (T1, T5/T6) through predictive mean matching. Gender, age and ethnicity where also used as predictors of the missing values. Nonetheless, we removed 86 participants with no MHRB information at all.

First, we calculated descriptive statistics for all variables. Second, in order to categorize adolescents, we identified trajectories of probabilities of MHRBs over time, together with changes in mental health between childhood (T1) and young adulthood (average of T5 and T6), using an extended version of the latent class growth analyses (LCGA). We defined each trajectory based simultaneously on three different elements: the longitudinal probability of MHRBs during adolescence (T2–T4) plus mental health at baseline, and the difference in mental health from baseline to T5/T6. We selected the number of trajectories based on diagnostic information (AIC, BIC, and aBIC) and the conceptual interpretation of the results. LCGA's were estimated via maximum-likelihood with robust standard errors and 1000 starting values, and (co)variances among mental health (baseline and changes) were also allowed to vary across classes. We used the BIC, aBIC, and AIC (averaged over the imputed datasets) to determine the most representative number of trajectories. Next, we assessed descriptives of covariates for the resulting trajectories. Third, we used ANOVA to assess associations between patterns of MHRBs over time (continuity of MHRBs, as well as early, mid- and late onset patterns), with changes in mental health (from baseline to wave 5/6) adjusted by sex, socioeconomic status and ethnicity. We repeated all analyses for the subgroups substance use and obesity-related lifestyle.

We performed the LCGA in Mplus version 8(Muthén and Muthén, 1998), and conducted the other statistical analyses using SPSS v.25.0 software (IBM Corp). Multiple imputation was conducted in R version 3.6.2 (R Core Team, 2020; package *mice*).

3. Results

3.1. Sample characteristics

Descriptive statistics are shown in Table 1. Adolescents had a predominantly Dutch ethnic background (87.0%), which is common for the north of The Netherlands, and over half of the sample consisted of girls (51.4%). Of all adolescents, 522 (24.4%) were raised in families with low socio-economic status (SES). The overall prevalence rates of adolescents with more than three MHRBs increased from 23% at age 13.5 to 80% at age 19. Similar results were found for the subgroups substance use and obesity-related lifestyle (increases from 54% to 89%, and 67% to 97%, respectively). We found an overall decrease in average mental health problems from age 11 to age 23 (0.34 to 0.29, respectively).

Table 1
Descriptive statistics of the sample (N= 2,143).

	T1	T2	T3	T4	T5/T6
Age in years, mean (SD)	11.11 (0.56)	13.57 (0.53)	16.28 (0.71)	19.08 (0.60)	23.08 (0.76)
Multiple health risk behaviors, N (%)					
All MHRBs[a]		496 (23%)	968 (45%)	1711 (80%)	
Substance use subgroup[b]		1155 (54%)	1708 (80%)	1912 (89%)	
Obesity-related subgroup[b]		1432 (67%)	1435 (67%)	2086 (97%)	
Mental health[c], mean (SD)	0.34 (0.19)				0.29 (0.20)

[a] We consider a cut off score of ≥ 3 multiple health risk behaviors per wave (T2–T4) in the total group.
[b] We consider a cut off score of ≥ 1 multiple health risk behaviors per wave (T2–T4) in the subgroups.
[c] YSR, ASR; total problem score.

3.2. Associations between MHRB patterns over time and changes in mental health

Using LCGA we identified six developmental trajectories for the total MHRBs, as well as for the subgroups substance use and obesity-related lifestyle (Table 2). Entropies were considered medium (Nagin, 2005). Trajectories varied in terms of probability of MHRBs over time (low, medium-high), their mental health at baseline, and their change in mental health in young adulthood. Fig. 1a shows two patterns of likelihood of MHRBs over time among the trajectories. A medium-high pattern with probabilities of MHRBs at wave 2 around 50%, increasing fast to approximately 90% at wave 4, and a low pattern with probabilities of MHRBs at wave 2 around 10%, growing after wave 3 up to approximately 60% at wave 4. The three medium-high trajectories (12.9%, 10.7%, and 23.9% of participants) showed moderate to high mental health problems at baseline. However, only one trajectory showed a significant decrease in mental health problems (12.9% of participants, $MH_{diff=}$ −0.07, $p < 0.05$). The three low trajectories (10.5%, 24.9%, and 17.1% of participants) showed low to moderate mental health problems at baseline. Two trajectories showed significant decreases in mental health (10.5% of participants, $MH_{diff=}$ −0.06, $p < 0.05$, 24.9% of participants, $MH_{diff=}$ −0.09, $p < 0.05$), however, differences were small. Descriptives statistics of the covariates per trajectory are shown in Supplementary Tables A–C. Two of the trajectories with a medium-high pattern show a rather higher proportion of families with low SES.

In the subgroups, *substance use* trajectories with a low pattern demonstrate a relatively higher proportion of families with high SES. The highest trajectory within the *obesity-related* subgroup consisted of more males, whereas the trajectory with significant decrease in mental health problems, consisted of more females. We found no associations for prolonged patterns of MHRBs throughout adolescence and changes in mental health (Table 3).

Fig. 1b shows two main patterns of probability of MHRBs over time among the trajectories of *substance use*, similar to the total of MHRBs mentioned above. However, most adolescents are part of the medium-high pattern (79.8% of participants). Adolescents in both patterns

Table 2
Comparative goodness of fit indices for the selected number of trajectories based on A) the longitudinal probability of MHRBs[a,b] at ages 13, 16, and 19, B) mental health at age 11, and C) outcome changes in mental health from age 11 to age 23.

	Number of classes[c]	Akaike information criterion[d]	Bayes information criterion[d]	Adjusted bayes information criterion	Entropy
All MHRBs[a]	1	5307.9	5353.3	5327.9	N/A
	2	4503.9	4600.3	4546.3	0.57
	3	4234.6	4382.0	4299.4	0.61
	4	4091.1	4289.6	4178.4	0.61
	5	4029.1	4278.6	4138.8	0.63
	6	3956.4	4256.9	4088.5	0.65
	7	3930.5	4282.0	4085.0	0.65
Substance use subgroup[b]	1	4471.0	4516.4	4491.0	N/A
	2	3725.4	3821.8	3767.8	0.57
	3	3332.1	3479.5	3396.9	0.65
	4	3186.6	3385.0	3273.8	0.64
	5	3110.0	3359.5	3219.7	0.65
	6	3063.1	3363.6	3195.2	0.64
	7	3041.4	3392.9	3195.9	0.69
Obesity-related subgroup[b]	1	3857.1	3902.5	3877.0	N/A
	2	3126.4	3222.8	3168.8	0.57
	3	2975.9	3123.3	3040.7	0.59
	4	2910.7	3109.2	2998.0	0.58
	5	2859.1	3108.6	2968.8	0.66
	6	2825.9	3126.4	2958.0	0.57
	7	2801.9	3153.5	2956.5	0.59

[a] We consider a cut off score of ≥ 3 multiple health risk behaviors per wave (T2–T4) in the overall group.
[b] We consider a cut off score of ≥ 1 multiple health risk behaviors per wave (T2–T4) in the subgroups.
[c] Used model is indicated in bold.
[d] Lower AIC and BIC values indicate a better model fit.

vary widely in mental health at baseline, as well as changes in mental health, however non significantly. Moreover, for the *obesity-related* subgroup, Fig. 1c shows again two main patterns of likelihood of MHRBs over time. However, trajectories have a large variability at wave 2 (30–100% of probability of MHRBs), and all trajectories grow until 100% at wave 4. We found no clear relationship with mental health. For example, the trajectories with the highest and the lowest mental health at baseline (resp. MH_1=0.57; MH_1=0.18) showed the same pattern in MHRBs, but the only trajectory with a significant decrease in mental health problems regarded a relatively low MHRB level-category (19.9 % of participants, MH_1=0.39, $MH_{diff} = -0.02$, $p < 0.05$).

3.3. Relationship between onset of MHRBs in adolescence and change in mental health

Early, mid- and late onset of MHRBs in adolescence were not associated with change in mental health from childhood to young adulthood. Regarding subgroups, prolonged patterns of *obesity-related lifestyle* were significantly linked to changes in mental health problems in young adulthood (Table 3; B=0.02, $p < 0.05$), indicating an increase in mental health problems compared to the other possible MHRB patterns.

4. Discussion

This study is the first to examine patterns of multiple health risk behavior (MHRB) in adolescence and changes in mental health from childhood to young adulthood. We found six trajectories of MHRB patterns MHRBs throughout adolescence (low, medium-high) with different levels of mental health problems at baseline, and, varying changes of mental health problems in young adulthood. Mental health problems at age 11 were an important predictor of mental health problems in young adulthood, in combination with the MHRB patterns. Continuity of MHRBs throughout adolescence predicted increases in mental health problems in young adulthood, but only for the obesity-related subgroup.

Adolescents with similar patterns regarding likelihood of MHRBs had varying levels of mental health at baseline, and also varying levels of change in mental health problems in young adulthood. For example, adolescents highly engaged in MHRBs were divided in three groups based on their level of childhood mental health and their rather different changes in mental health. These combinations suggest that MHRBs explain only a small part of the changes in mental health. This shows that mental health and MHRB patterns should be assessed jointly, to discriminate those groups which require combined efforts on these two types of outcomes (Child Mind Institute, 2021). However, MHRB patterns seem to interpose the association of mental health at age 11 with mental health problems in young adulthood. This finding is hard to compare to previous research. Extensive research has been done on trajectories of MHRBs (Mahalik et al., 2013; Peeters et al., 2019), but no prior research used trajectories based on all three measures simultaneously: mental health at baseline, patterns of MHRBs in adolescence, and changes in mental health in young adulthood. This makes it difficult to compare results. A possible explanation for our findings may be that both MHRBs and mental health during adolescence are also subject to various other factors, which modify the associations. Examples may include self-control (Finkenauer et al., 2005), family functioning (Simpson et al., 2018), stressful life events (McLaughlin and Hatzenbuehler, 2009), and resilience of adolescents who face adversities (Sagone et al., 2020), which have shown to affect associations of mental health in adolescence and single HRBs (Skogen et al., 2016; Tucker et al., 2005). Evidently, such potential moderators deserve further study.

For the obesity-related subgroup, continuity of MHRBs throughout adolescence was associated with increases in mental health problems in young adulthood. These findings are consistent with those of Mumford et al. (2013), who found an association between becoming obese and experiencing a decline in mental health from adolescence to young adulthood. A possible explanation may be that adolescence marks a critical transition from the care of the family to more independence, which is often accompanied by a less healthy lifestyle (Mumford et al., 2013). Another explanation may be that engaging in various HRBs could be a form of coping with stressors (Gould et al., 2012; Pampel et al., 2010), as described in the theory of self-medication. Stress has, for example, been shown to be associated with a craving for "comfort foods"(Dallman et al., 2005), as part of an unhealthy lifestyle. Regarding substance use, such as alcohol, Lisdahl et al. (2013) found an early onset of alcohol use to be linked to greater mental health problems, whereas we found no association. An explanation may be that we used strict national health guidelines: "no alcohol use". Some experimentation with low levels of substance use, such as smoking a cigarette or drinking

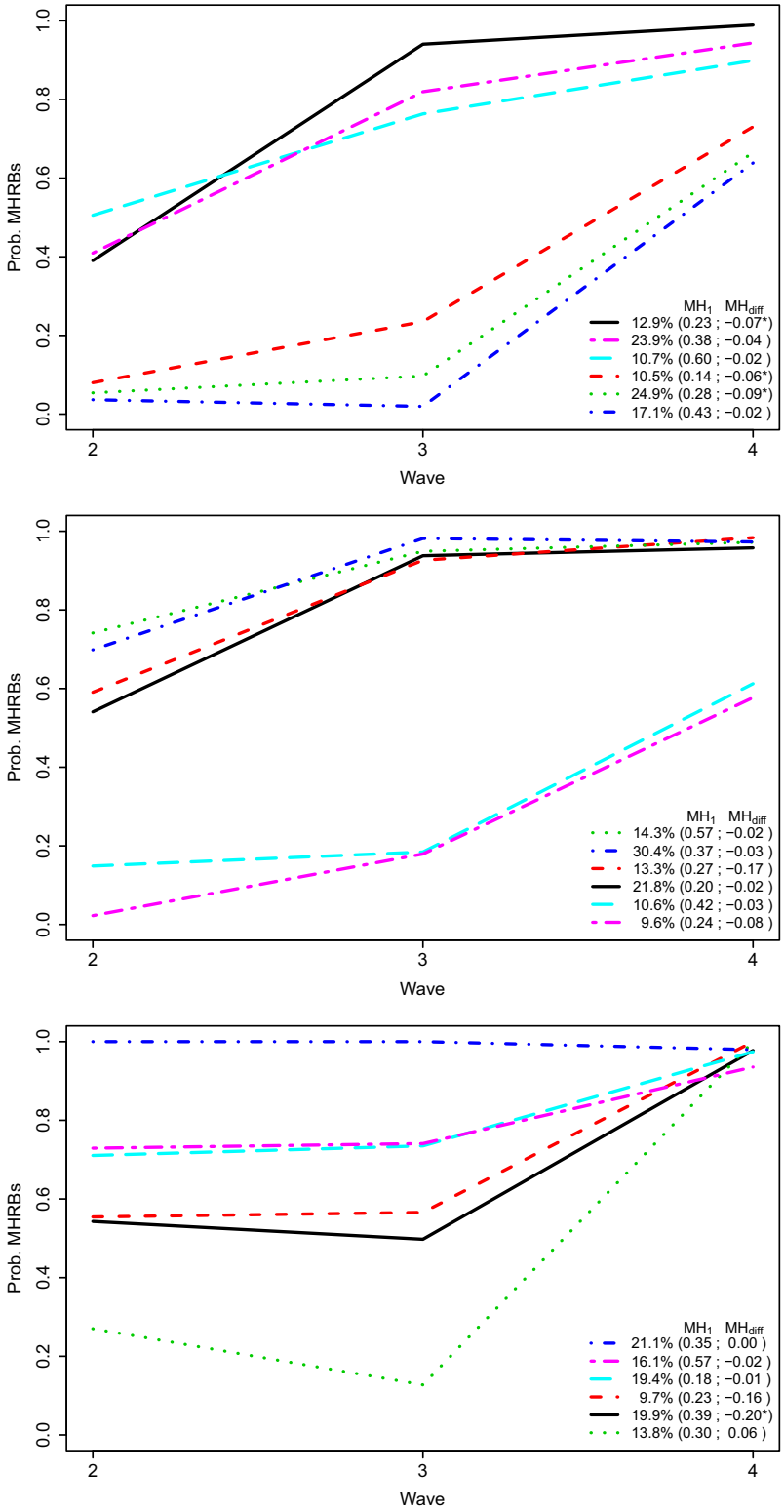

Fig. 1. (a) Trajectories of individuals categorized according to probability of co-occurring MHRBs over time (T2–T4), and levels of mental health problems at baseline (age 11) and at age 23. (b) Trajectories of individuals categorized according to probability of substance use over time (T2–T4), levels of mental health problems at baseline (age 11) and at age 23. (c) Trajectories of individuals categorized according to probability of obesity-related lifestyle over time (T2–T4), and levels of mental health problems at baseline (age 11) and at age 23.

[a] MH-diff refers to the average change in mental health problems from adolescence to young adulthood (expected values of outcome mental health - mean T5 and T6 - minus mental health at T1).

[b] MH1 refers to the average in mental health problems at baseline (T1).

* MH-diff statistically different from zero ($p < 0.05$).

alcohol, might be an opportunity for adolescents to explore their self or identity (Arbeit et al., 2014; Yu et al., 2017), and not constitute long term problems like mental health issues.

4.1. Strengths and limitations

This study has several strengths. First, it includes a large population-based cohort with high response rates and low dropout across the various follow-ups. Second, it uses data over six waves, covering a long trajectory from childhood to adulthood. Third, it combines variance and trajectory analyses. The ANOVA estimated average mental health changes of predefined MHRB patterns, and the latent class growth analyses enabled us to uncover meaningful distinct trajectories for MHRB patterns over time and a long-term mental health outcome, taking into

Table 3
Changes in mental health problems from early adolescence until young adulthood, per MHRB pattern at ages 13, 16, and 19 (T2–T4): regression coefficients (B) with 95% confidence intervals (CI) for changes in mental health problems from age 11 to age 23, measured by YSR/ASR scores.

		Changes in mental health problems		
MHRB patterns[b, f]		N[c]	B[a]	95%CI
	All MHRBs[d]	349	−0.00	[−0.03; 0.03]
	Substance use subgroup[e]	1033	−0.02	[−0.04; 0.00]
	Obesity-related			
Prolonged (111)	subgroup[e]	1040	0.02*	[0.00; 0.04]
	All MHRBs[d]	496	−0.01	[−0.04; 0.02]
	Substance use subgroup[e]	1155	−0.02	[−0.04; 0.00]
	Obesity-related			
Early onset (0**)	subgroup[e]	1432	0.01	[−0.01; 0.03]
	All MHRBs[d]	968	0.01	[−0.01; 0.04]
	Substance use subgroup[e]	1708	0.01	[−0.02; 0.04]
	Obesity-related			
Mid onset (01*)	subgroup[e]	1435	0.02	[−0.01; 0.05]
	All MHRBs[d]	1711	0.02	[−0.01; 0.05]
	Substance use subgroup[e]	2086	−0.00	[−0.04; 0.03]
	Obesity-related			
Late onset (001)	subgroup[e]	1912	0.01	[−0.07;−0.09]

Estimates(B) with 95% confidence intervals (CI).
[a] Each row corresponds to one regression analysis with a specific MHRB patterns as predictor, relative to all other MHRB patterns.
[b] Patterns indicated by a string of three binary codes to indicate the presence of MHRBs per wave ('1), the absence of MHRBs ('0'), or either value ('*') at wave T2, T3 or T4.
[c] Average N over all imputed datasets.
[d] We considered a cut off score of ≥ 3 multiple health risk behaviors per wave (T2–T4) in the overall group.
[e] We considered a cut off score of ≥ 1 multiple health risk behaviors per wave (T2–T4) in the subgroups.
[f] Analyses were controlled for the variables sex, socioeconomic status and ethnicity.
* $p < 0.05$.

account that repeated measurements of HRBs might be correlated.

However, the study also has some limitations. Although our interest was to measure MHRBs using a clustering approach (McAloney et al., 2013), the combination of two different analyses allowed us to only measure co-occurrence of HRBs, i.e. a sum score of dichotomized seperate HRBs. Moreover, the construction of trajectories may not have fully captured the variability of MHRB patterns in the population, as e.g. all trajectories in our sample had high probabilities of MHRBs at wave 4. Therefore, we could not estimate what could have been the impact of all possible patterns, such as no presence or decreasing patterns of MHRBs on long-term mental health. Nevertheless, this may simply represent the pattern of accumulation of HRBs (de Winter et al., 2016) during adolescence. A further limitation was that all measures were self-reported, which could result in underestimation of the occurrence of problems. However, measurement scores were all reliable and valid, and anonymity was assured (Del Boca and Darkes, 2003). Finally, we could not control for all potential confounders, since parental MHRBs were not measured. A sensitivity analysis showed no impact of parental mental health in our models; therefore this variable was not included as a covariate (see Supplementary Tables D and E). While the trajectories in our study provide further insight, the categorization of adolescents deserves further study. More precise classification enables a further improvement of targeted interventions.

4.2. Implications

Adolescents in this cohort involved in MHRBs, now adults, were at risk of mental health problems, especially if they already experienced mental health problems as a child. Future research should investigate mechanisms and moderators of the reported associations, such as family, individual, and peer factors that may build resilience against the temptation to engage in MHRBs, thereby helping to prevent or minimize consequences of deteriorating mental health in adulthood, and understand the emergence of its complexity. Our findings regarding mental health at age 11 point to the importance of the onset of mental health problems in combination with MHRBs. These risks should be confirmed by future research, as they may imply more focus in preventive interventions aimed on adolescent risk behavior and mental health. A standardized categorization of MHRBs can add value to this research. Our findings further deserve replication among ethnically more diverse populations.

5. Conclusion

In conclusion, this life-course study provided a unique insight into the trajectories and long-term associations between MHRBs and mental health. Our results suggest that although during their teenage years adolescents may share similar MHRB patterns, they can reach adulthood with different levels of changes in mental health problems, most likely if they experienced mental health issues as a child.

Declaration of competing interest

The authors have no conflicts of interest to declare.

Acknowledgements

We thank all participants in this research, and everyone who worked on this project to make it possible. This research is part of the TRacking Adolescents' Individual Lives Survey (TRAILS). Participating centers of TRAILS include various departments of the University Medical Center and University of Groningen, the University of Utrecht, the Radboud Medical Center Nijmegen, and the Parnassia Bavo group, all in The Netherlands. Research reported in this publication is funded through the Dutch Organization of Scientific Research (NWO grant number 400.17.601). The authors have no conflicts of interest to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2021.106870.

References

Achenbach, T., Rescorla, L., 2001. Manual for the ASEBA School-Age Forms & Profiles. University of Vermont, Research Center for Children, Youth & Families, Burlington, VT.
Achenbach, T., Rescorla, L., 2003. Manual for the ASEBA Adult Forms & Profiles. University of Vermont, Research Center for Children, Youth & Families, Burlington, VT.
Arbeit, M.R., Johnson, S.K., Champine, R.B., Greenman, K.N., Lerner, J.V., Lerner, R.M., 2014. Profiles of problematic behaviors across adolescence: covariations with indicators of positive youth development. J. Youth Adolesc. 43, 971–990. https://doi.org/10.1007/s10964-014-0092-0.
Bentham, J., Di Cesare, M., Bilano, V., Bixby, H., Zhou, B., Stevens, G.A., Riley, L.M., Taddei, C., Hajifathalian, K., Lu, Y., Savin, S., Cowan, M.J., Paciorek, C.J., Chirita-Emandi, A., Hayes, A.J., Katz, J., Kelishadi, R., Kengne, A.P., Khang, Y.H., Laxmaiah, A., Li, Y., Ma, J., Miranda, J.J., Mostafa, A., Neovius, M., Padez, C., Rampal, L., Zhu, A., Bennett, J.E., Danaei, G., Bhutta, Z.A., Ezzati, M., Abarca-Gómez, L., Abdeen, Z.A., Hamid, Z.A., Abu-Rmeileh, N.M., Acosta-Cazares, B., Acuin, C., Adams, R.J., Aekplakorn, W., Afsana, K., Aguilar-Salinas, C.A., Agyemang, C., Ahmadvand, A., Ahrens, W., Ajlouni, K., Akhtaeva, N., Al-Hazzaa, H. M., Al-Othman, A.R., Al-Raddadi, R., Albuhairan, F., Aldhukair, S., Ali, M.M., Ali, O., Alkerwi, A., Alvarez-Pedrerol, M., Aly, E., Amarapurkar, D.N., Amouyel, P., Amuzu, A., Andersen, L.B., Anderssen, S.A., Andrade, D.S., Ängquist, L.H., Anjana, R.M., Aounallah-Skhiri, H., Araújo, J., Ariansen, I., Aris, T., Arlappa, N., Arveiler, D., Aryal, K.K., Aspelund, T., Assah, F.K., Assunção, M.C.F., Aung, M.S., Avdicová, M., Azevedo, A., Azizi, F., Babu, B.V., Bahijri, S., Baker, J.L., Balakrishna, N., Bamoshmoosh, M., Banach, M., Bandosz, P., Banegas, J.R., Barbagallo, C.M., Barceló, A., Barkat, A., Barros, A.J.D., Barros, M.V.G., Bata, I., Batieha, A.M., Batista, R.L., Batyrbek, A., Baur, L.A., Beaglehole, R., Romdhane, H.

Ben, Benedics, J., Benet, M., Bernabe-Ortiz, A., Bernotiene, G., Bettiol, H., Bhagyalaxmi, A., Bharadwaj, S., Bhargava, S.K., Bhatti, Z., Bi, H., Bi, Y., Biehl, A., Bikbov, M., Bista, B., Bjelica, D.J., Bjerregaard, P., Bjertness, E., Bjertness, M.B., Björkelund, C., Blokstra, A., Bo, S., Bobak, M., Boddy, L.M., Boehm, B.O., Boeing, H., Boggia, J.G., Boissonnet, C.P., Bonaccio, M., Bongard, V., Bovet, P., Braeckevelt, L., Braeckman, L., Bragt, M.C.E., Brajkovich, I., Branca, F., Breckenkamp, J., Breda, J., Brenner, H., Brewster, L.M., Brian, G.R., Brinduse, L., Bruno, G., Bueno-De-mesquita, H.B., Bugge, A., Buoncristiano, M., Burazeri, G., Burns, C., de León, A.C., Cacciottolo, J., Cai, H., Cama, T., Cameron, C., Camolas, J., Can, G., Cândido, A.P.C., Capanzana, M., Capuano, V., Cardoso, V.C., Carlsson, A.C., Carvalho, M.J., Casanueva, F.F., Casas, J.P., Caserta, C.A., Chamukuttan, S., Chan, A.W., Chan, Q., Chaturvedi, H.K., Chaturvedi, N., Chen, C.J., Chen, F., Chen, H., Chen, S., Chen, Z., Cheng, C.Y., Chetrit, A., Chikova-Iscener, E., Chiolero, A., Chiou, S.T., Chirlaque, M. D., Cho, B., Cho, Y., Christensen, K., Christofaro, D.G., Chudek, J., Cifkova, R., Cinteza, E., Claessens, F., Clays, E., Concin, H., Confortin, S.C., Cooper, C., Cooper, R., Coppinger, T.C., Costanzo, S., Cottel, D., Cowell, C., Craig, C.L., Crujeiras, A.B., Cucu, A., D'arrigo, G., D'orsi, E., Dallongeville, J., Damasceno, A., Damsgaard, C.T., Dankner, R., Dantoft, T.M., Dastgiri, S., Dauchet, L., Davletov, K., De Backer, G., De Bacquer, D., De Curtis, A., de Gaetano, G., De Henauw, S., de Oliveira, P.D., De Ridder, K., De Smedt, D., Deepa, M., Deev, A.D., Dehghan, A., Delisle, H., Delpeuch, F., Deschamps, V., Dhana, K., Di Castelnuovo, A.F., Dias-Da-costa, J.S., Diaz, A., Dika, Z., Djalalinia, S., Do, H.T.P., Dobson, A.J., Donati, M.B., Donfrancesco, C., Donoso, S.P., Döring, A., Dorobantu, M., Dorosty, A.R., Doua, K., Drygas, W., Duan, J.L., Duante, C., Duleva, V., Dulskiene, V., Dzerve, V., Dziankowska-Zaborszczyk, E., Egbagbe, E.E., Eggertsen, R., Eiben, G., Ekelund, U., El Ati, J., Elliott, P., Engle-Stone, R., Erasmus, R.T., Erem, C., Eriksen, L., Eriksson, J. G., De la Peña, J.E., Evans, A., Faeh, D., Fall, C.H., Sant'angelo, V.F., Farzadfar, F., Felix-Redondo, F.J., Ferguson, T.S., Fernandes, R.A., Fernández-Bergés, D., Ferrante, D., Ferrari, M., Ferreccio, C., Ferrieres, J., Finn, J.D., Fischer, K., Flores, E. M., Föger, B., Foo, L.H., Forslund, A.S., Forsner, M., Fouad, H.M., Francis, D.K., Franco, M.D.C., Franco, O.H., Frontera, G., Fuchs, F.D., Fuchs, S.C., Fujita, Y., Furusawa, T., Gaciong, Z., Gafencu, M., Galeone, D., Galvano, F., Garcia-De-la-hera, M., Gareta, D., Garnett, S.P., Gaspoz, J.M., Gasull, M., Gates, L., Geiger, H., Geleijnse, J.M., Ghasemian, A., Giampaoli, S., Gianfagna, F., Gill, T.K., Giovannelli, J., Giwercman, A., Godos, J., Gogen, S., Goldsmith, R.A., Goltzman, D., Gonçalves, H., González-Leon, M., González-Rivas, J.P., Gonzalez-Gross, M., Gottrand, F., Graça, A.P., Graff-Iversen, S., Grafnetter, D., Grajda, A., Grammatikopoulou, M.G., Gregor, R.D., Grodzicki, T., Grøntved, A., Grosso, G., Gruden, G., Grujic, V., Gu, D., Gualdi-Russo, E., Guallar-Castillón, P., Guan, O.P., Gudmundsson, E.F., Gudnason, V., Guerrero, R., Guessous, I., Guimaraes, A.L., Gulliford, M.C., Gunnlaugsdottir, J., Gunter, M., Guo, X., Guo, Y., Gupta, P.C., Gupta, R., Gureje, O., Gurzkowska, B., Gutierrez, L., Gutzwiller, F., Hadaegh, F., Hadjigeorgiou, C.A., Si-Ramlee, K., Halkjær, J., Hambleton, I.R., Hardy, R., Kumar, R.H., Hassapidou, M., Hata, J., He, J., Heidinger-Felso, R., Heinen, M., Hendriks, M.E., Henriques, A., Cadena, L.H., Herrala, S., Herrera, V.M., Herter-Aeberli, I., Heshmat, R., Hihtaniemi, I.T., Ho, S.Y., Ho, S.C., Hobbs, M., Hofman, A., Hopman, W.M., Horimoto, A.R.V.R., Hormiga, C.M., Horta, B.L., Houti, L., Howitt, C., Htay, T.T., Htet, A.S., Htike, M.M.T., Hu, Y., Huerta, J.M., Petrescu, C.H., Huisman, M., Husseini, A., Huu, C.N., Huybrechts, I., Hwalla, N., Hyska, J., Iacoviello, L., Iannone, A.G., Ibarluzea, J.M., Ibrahim, M.M., Ikeda, N., Ikram, M.A., Irazola, V.E., Islam, M., Ismail, A.A.S., Ivkovic, V., Iwasaki, M., Jackson, R.T., Jacobs, J.M., Jaddou, H., Jafar, T., Jamil, K.M., Jamrozik, K., Janszky, I., Jarani, J., Jasienska, G., Jelaković, A., Jelaković, B., Jennings, G., Jeong, S.L., Jiang, C.Q., Jiménez-Acosta, S.M., Joffres, M., Johansson, M., Jonas, J.B., Jørgensen, T., Joshi, P., Jovic, D.P., Jóźwiak, J., Juolevi, A., Jurak, G., Jureša, V., Kaaks, R., Kafatos, A., Kajantie, E.O., Kalter-Leibovici, O., Kamaruddin, N.A., Kapantais, E., Karki, K.B., Kasaeian, A., Kauhanen, J., Kaur, P., Kavousi, M., Kazakbaeva, G., Keil, U., Boker, L.K., Keinänen-Kiukaanniemi, S., Kelleher, C., Kemper, H.C.G., Kerimkulova, A., Kersting, M., Key, T., Khader, Y.S., Khalili, D., Khateeb, M., Khaw, K.T., Khouw, I.M.S.L., Kiechl-Kohlendorfer, U., Kiechl, S., Killewo, J., Kim, J., Kim, Y.Y., Klimont, J., Klumbiene, J., Knoflach, M., Koirala, B., Kolle, E., Kolsteren, P., Korrovits, P., Kos, J., Koskinen, S., Kouda, K., Kovacs, V.A., Kowlessur, S., Koziel, S., Kratzer, W., Kriemler, S., Kristensen, P.L., Krokstad, S., Kromhout, D., Kruger, H.S., Kubinova, R., Kuciene, R., Kuh, D., Kujala, U.M., Kulaga, Z., Kumar, R.K., Kunešová, M., Kurjata, P., Kusuma, Y.S., Kuulasmaa, K., Kyobutungi, C., La, Q.N., Laamiri, F.Z., Laatikainen, T., Lachat, C., Laid, Y., Lam, T. H., Landrove, O., Lanska, V., Lappas, G., Larijani, B., Laugsand, L.E., Lauria, L., Bao, K.L.N., Le, T.D., Lebanan, M.A.O., Leclercq, C., Lee, Jeannette, Lee, Jeonghee, Lehtimäki, T., León-Muñoz, L.M., Levitt, N.S., Lilly, C.L., Lim, W.Y., Lima-Costa, M. F., Lin, H.H., Lin, X., Lind, L., Linneberg, A., Lissner, L., Litwin, M., Liu, J., Loit, H.M., Lopes, L., Lorbeer, R., Lotufo, P.A., Lozano, J.E., Luksiene, D., Lundqvist, A., Lunet, N., Lytsy, P., Ma, G., Machado-Coelho, G.L.L., Machado-Rodrigues, A.M., Machi, S., Maggi, S., Magliano, D.J., Magriplis, E., Mahaletchumy, A., Maire, B., Majer, M., Makdisse, M., Malekzadeh, R., Malhotra, R., Rao, K.M., Malyutina, S., Manios, Y., Mann, J.I., Manzato, E., Margozzini, P., Markaki, A., Markey, O., Marques, L.P., Marques-Vidal, P., Marrugat, J., Martin-Prevel, Y., Martin, R., Martorell, R., Martos, E., Marventano, S., Masoodi, S.R., Mathiesen, E.B., Matijasevich, A., Matsha, T.E., Mazur, A., Mbanya, J.C.N., McFarlane, S.R., McGarvey, S.T., McKee, M., McLachlan, S., McLean, R.M., McLean, S.B., McNulty, B. A., Yusof, S.M., Mediene-Benchekor, S., Medzioniene, J., Meirhaeghe, A., Meisfjord, J., Meisinger, C., Menezes, A.M.B., Menon, G.R., Mensink, G.B.M., Meshram, I.I., Metspalu, A., Meyer, H.E., Mi, J., Michaelsen, K.F., Michels, N., Mikkel, K., Miller, J.C., Minderico, C.S., Miquel, J.F., Mirkopoulou, D., Mirrakhimov, E., Mišigoj-Durakovic, M., Mistretta, A., Mocanu, V., Modesti, P.A., Mohamed, M.K., Mohammad, K., Mohammadifard, N., Mohan, V., Mohanna, S., Yusoff, M.F.M., Molbo, D., Møllehave, L.T., Møller, N.C., Molnár, D., Momenan, A., Mondo, C.K., Monterrubio, E.A., Monyeki, K.D.K., Moon, J.S., Moreira, L.B., Morejon, A., Moreno, L.A., Morgan, K., Mortensen, E.L., Moschonis, G., Mossakowska, M., Mota, J., Mota-Pinto, A., Motlagh, M.E., Motta, J., Mu, T.T., Muc, M., Muiesan, M.L., Müller-Nurasyid, M., Murphy, N., Mursu, J., Murtagh, E.M., Musil, V., Nabipour, I., Nagel, G., Naidu, B.M., Nakamura, H., Námešná, J., Nang, E. E.K., Nangia, V.B., Nankap, M., Narake, S., Nardone, P., Navarrete-Muñoz, E.M., Neal, W.A., Nenko, I., Nervi, F., Nguyen, C.T., Nguyen, N.D., Nguyen, Q.N., Nieto-Martínez, R.E., Ning, G., Ninomiya, T., Nishtar, S., Noale, M., Noboa, O.A., Norat, T., Norie, S., Noto, D., Al Nsour, M., O'reilly, D., Obreja, G., Oda, E., Oehlers, G., Oh, K., Ohara, K., Olafsson, Ö., Olinto, M.T.A., Oliveira, I.O., Oltarzewski, M., Omar, M.A., Onat, A., Ong, S.K., Ono, L.M., Ordunez, P., Ornelas, R., Ortiz, A.P., Osler, M., Osmond, C., Ostojic, S.M., Ostovar, A., Otero, J.A., Overvad, K., Owusu-Dabo, E., Paccaud, F.M., Pahomova, E., Pajak, A., Palli, D., Palloni, A., Palmieri, L., Pan, W.H., Panda-Jonas, S., Pandey, A., Panza, F., Papandreou, D., Park, S.W., Parnell, W.R., Parsaeian, M., Pascanu, I.M., Patel, N.D., Pećin, I., Pednekar, M.S., Peer, N., Peeters, P.H., Peixoto, S.V., Peltonen, M., Pereira, A.C., Perez-Farinos, N., Pérez, C. M., Peters, A., Petkeviciene, J., Petrauskiene, A., Peykari, N., Pham, S.T., Pierannunzio, D., Pigeot, I., Pikhart, H., Pilav, A., Pilotto, L., Pistelli, F., Pitakaka, F., Piwonska, A., Plans-Rubió, P., Poh, B.K., Pohlabeln, H., Pop, R.M., Popovic, S.R., Porta, M., Portegies, M.L.P., Posch, G., Poulimeneas, D., Pouraram, H., Pourshams, A., Poustchi, H., Pradeepa, R., Prashant, M., Price, J.F., Puder, J.J., Pudule, I., Puiu, M., Punab, M., Qasrawi, R.F., Qorbani, M., Bao, T.Q., Radic, I., Radisauskas, R., Rahman, Mahfuzar, Rahman, Mahmudur, Raitakari, O., Raj, M., Rao, S.R., Ramachandran, A., Ramke, J., Ramos, E., Ramos, R., Rampal, S., Rascon-Pacheco, R.A., Redon, J., Reganit, P.F.M., Ribas-Barba, L., Ribeiro, R., Riboli, E., Rigo, F., de Wit, T.F.R., Rito, A., Ritti-Dias, R.M., Rivera, J.A., Robinson, S.M., Robitaille, C., Rodrigues, D., Rodríguez-Artalejo, F., Rodriguez-Perez, M.D.C., Rodríguez-Villamizar, L.A., Rojas-Martinez, R., Rojroongwasinkul, N., Romaguera, D., Ronkainen, K., Rosengren, A., Rouse, I., Roy, J.G.R., Rubinstein, A., Rühli, F.J., Ruiz-Betancourt, B.S., Russo, P., Rutkowski, M., Sabanayagam, C., Sachdev, H.S., Saidi, O., Salanave, B., Martinez, E.S., Salmerón, D., Salomaa, V., Salonen, J.T., Salvetti, M., Sánchez-Abanto, J., Sandjaja, Sans, S., Marina, L.S., Santos, D.A., Santos, I.S., Santos, O., Dos Santos, R.N., Santos, R., Saramies, J.L., Sardinha, L.B., Sarrafzadegan, N., Saum, K.U., Savva, S., Savy, M., Scazufca, M., Rosario, A.S., Schargrodsky, H., Schienkiewitz, A., Schipf, S., Schmidt, C.O., Schmidt, I.M., Schultsz, C., Schutte, A.E., Sein, A.A., Sen, A., Senbanjo, I.O., Sepanlou, S.G., Serra-Majem, L., Shalnova, S.A., Sharma, S.K., Shaw, J.E., Shibuya, K., Shin, D.W., Shin, Y., Shiri, R., Siani, A., Siantar, R., Sibai, A.M., Silva, A. M., Silva, D.A.S., Simon, M., Simons, J., Simons, L.A., Sjöberg, A., Sjöström, M., Skovbjerg, S., Slowikowska-Hilczer, J., Slusarczyk, P., Smeeth, L., Smith, M.C., Snijder, M.B., So, H.K., Sobngwi, E., Söderberg, S., Soekatri, M.Y.E., Solfrizzi, V., Sonestedt, E., Song, Y., Sørensen, T.I.A., Soric, M., Jérome, C.S., Soumare, A., Spinelli, A., Spiroski, I., Staessen, J.A., Stamm, H., Starc, G., Stathopoulou, M.G., Staub, K., Stavreski, B., Steene-Johannessen, J., Stehle, P., Stein, A.D., Stergiou, G.S., Stessman, J., Stieber, J., Stöckl, D., Stocks, T., Stokwiszewski, J., Stratton, G., Stronks, K., Strufaldi, M.W., Suárez-Medina, R., Sun, C.A., Sundström, J., Sung, Y.T., Sunyer, J., Suriyawongpaisal, P., Swinburn, B.A., Sy, R.G., Szponar, L., Tai, E.S., Tammesoo, M.L., Tamosiunas, A., Tan, E.J., Tang, X., Tanser, F., Tao, Y., Tarawneh, M.R., Tarp, J., Tarqui-Mamani, C.B., Tautu, O.F., Braunerová, R.T., Taylor, A., Tchibindat, F., Theobald, H., Theodoridis, X., Thijs, L., Thuesen, B.H., Tjonneland, A., Tolonen, H.K., Tolstrup, J.S., Topbas, M., Topór-Madry, R., Tormo, M.J., Tornaritis, M.J., Torrent, M., Toselli, S., Traissac, P., Trichopoulos, D., Trichopoulou, A., Trinh, O.T.H., Trivedi, A., Tshepo, L., Tsigga, M., Tsugane, S., Tulloch-Reid, M.K., Tullu, F., Tuomainen, T.P., Tuomilehto, J., Turley, M.L., Tynelius, P., Tzotzas, T., Tzourio, C., Ueda, P., Ugel, E.E., Ukoli, F.A.M., Ulmer, H., Unal, B., Uusitalo, H.M.T., Valdivia, G., Vale, S., Valvi, D., van der Schouw, Y.T., Van Herck, K., Van Minh, H., van Rossem, L., Van Schoor, N.M., van Valkengoed, I.G.M., Vanderschueren, D., Vanuzzo, D., Vatten, L., Vega, T., Veidebaum, T., Velasquez-Melendez, G., Velika, B., Veronesi, G., Verschuren, W.M., Victora, C.G., Viegi, G., Viet, L., Viikari-Juntura, E., Vineis, P., Vioque, J., Virtanen, J.K., Visvikis-Siest, S., Viswanathan, B., Vlasoff, T., Vollenweider, P., Völzke, H., Voutilainen, S., Vrijheid, M., Wade, A.N., Wagner, A., Waldhör, T., Walton, J., Wan Bebakar, W.M., Wan Mohamud, W.N., Wanderley, R.S., Wang, M.D., Wang, Q., Wang, Y.X., Wang, Y. W., Wannamethee, S.G., Wareham, N., Weber, A., Wedderkopp, N., Weerasekera, D., Whincup, P.H., Widhalm, K., Widyahening, I.S., Wiecek, A., Wijga, A.H., Wilks, R.J., Willeit, J., Willeit, P., Wilsgaard, T., Wojtyniak, B., Wong-Mcclure, R.A., Wong, J.Y. Y., Wong, J.E., Wong, T.Y., Woo, J., Woodward, M., Wu, F.C., Wu, J., Wu, S., Xu, H., Xu, L., Yamborisut, U., Yan, W., Yang, X., Yardim, N., Ye, X., Yiallouros, P.K., Yngve, A., Yoshihara, A., You, Q.S., Younger-Coleman, N.O., Yusoff, F., Zaccagni, L., Zafiropulos, V., Zainuddin, A.A., Zambon, S., Zampelas, A., Zamrazilová, H., Zdrojewski, T., Zeng, Y., Zhao, D., Zhao, W., Zheng, W., Zheng, Y., Zholdin, B., Zhou, M., Zhu, D., Zhussupov, B., Zimmermann, E., Cisneros, J.Z., 2017. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. Lancet 390, 2627–2642. https://doi.org/10.1016/S0140-6736(17)32129-3.

Child Mind Institute, 2021. Complete Guide to Substance Use + Mental Health [WWW Document]. URL. https://childmind.org/guide/parents-guide-to-substance-use-mental-health/ (accessed 10.1.21).

Cole, T.J., Bellizzi, M.C., Flegal, K.M., Dietz, W.H., 2000. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 320, 1240.

Dallman, M.F., Pecoraro, N.C., La Fleur, S.E., 2005. Chronic stress and comfort foods: Self-medication and abdominal obesity. Brain Behav. Immun. 19, 275–280. https://doi.org/10.1016/j.bbi.2004.11.004.

De Winter, A.F., Oldehinkel, A.J., Veenstra, R., Brunnekreef, J.A., Verhulst, F.C., Ormel, J., 2005. Evaluation of non-response bias in mental health determinants and outcomes in a large sample of pre-adolescents. Eur. J. Epidemiol. 20, 173–181. https://doi.org/10.1007/s10654-004-4948-6.

de Winter, A.F., Visser, L., Verhulst, F.C., Vollebergh, W.A.M., Reijneveld, S.A., 2016. Longitudinal patterns and predictors of multiple health risk behaviors among adolescents: the TRAILS study. Prev. Med. (Baltim). 84, 76–82. https://doi.org/10.1016/j.ypmed.2015.11.028.

Del Boca, F., Darkes, J., 2003. The validity of self-reports of alcohol consumption: state of the science and challenges for research. Addiction 98, 1–12. https://doi.org/10.1046/j.1359-6357.2003.00586.x.

Dusseldorp, E., Klein Velderman, M., Paulussen, T.W.G.M., Junger, M., van Nieuwenhuijzen, M., Reijneveld, S.A., 2014. Targets for primary prevention: cultural, social and intrapersonal factors associated with co-occurring health-related behaviours. Psychol. Health 29, 598–611. https://doi.org/10.1080/08870446.2013.879137.

Finkenauer, C., Engels, R.C.M.E., Baumeister, R.F., 2005. Parenting behaviour and adolescent behavioural and emotional problems: the role of self-control. Int. J. Behav. Dev. 29, 58–69. https://doi.org/10.1080/01650250444000333.

Freyer-Adam, J., Gaertner, B., Tobschall, S., John, U., 2011. Health risk factors and self-rated health among job-seekers. BMC Public Health 11. https://doi.org/10.1186/1471-2458-11-659.

Gezondheidsraad, 2015. Alcohol - Achtergronddocument bij Richtlijnen Goede Voeding. Den Haag.

Gould, L.F., Hussong, A.M., Hersh, M.A., 2012. Emotional distress may increase risk for self-medication and lower risk for mood-related drinking consequences in adolescents. Int. J. Emot. Educ. 4, 6–24.

Graham, J.W., 2009. Missing data analysis: making it work in the real world. Annu. Rev. Psychol. 60, 549–576. https://doi.org/10.1146/annurev.psych.58.110405.085530.

Hale, D.R., Fitzgerald-Yau, N., Viner, R.M., 2014. A systematic review of effective interventions for reducing multiple health risk behaviors in adolescence. Am. J. Public Health 104, 19–41. https://doi.org/10.2105/AJPH.2014.301874.

Haskell, W.L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C.A., Heath, G.W., Thompson, P.D., Bauman, A., 2007. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation 116, 1081–1093. https://doi.org/10.1161/CIRCULATIONAHA.107.185649.

Heikkala, E., Remes, J., Paananen, M., Taimela, S., Auvinen, J., Karppinen, J., 2014. Accumulation of lifestyle and psychosocial problems and persistence of adverse lifestyle over two-year follow-up among Finnish adolescents. BMC Public Health 14, 1–10. https://doi.org/10.1186/1471-2458-14-542.

Huisman, M., Oldehinkel, A.J., De Winter, A., Minderaa, R.B., De Bildt, A., Huizink, A.C., Verhulst, F.C., Ormel, J., 2008. Cohort profile: the Dutch "TRacking Adolescents" individual lives' survey'; TRAILS. Int. J. Epidemiol. 37, 1227–1235. https://doi.org/10.1093/ije/dym273.

IBM Corp, Released 2017. IBM SPSS Statistics for Windows, Version 25.0. IBM Corp, Armonk, NY.

Klein Velderman, M., Dusseldorp, E., van Nieuwenhuijzen, M., Junger, M., Paulussen, T.W.G.M., Reijneveld, S.A., 2014. Cultural, social and intrapersonal factors associated with clusters of co-occurring health-related behaviours among adolescents. Eur. J. Pub. Health 25, 31–37.

Kuh, D., Ben-Shlomo, Y., Lynch, J., Hallqvist, J., 2003. Life course epidemiology. J. Epidemiol. Community Health 57, 778–783.

Lisdahl, K.M., Gilbart, E.R., Wright, N.E., Shollenbarger, S., 2013. Dare to delay? The impacts of adolescent alcohol and marijuana use onset on cognition, brain structure, and function. Front. Psychiatry 4, 1–19. https://doi.org/10.3389/fpsyt.2013.00053.

Little, R.J., D'Agostino, R., Cohen, M.L., Dickersin, K., Emerson, S.S., Farrar, J.T., Frangakis, C., Hogan, J.W., Molenberghs, G., Murphy, S.A., Neaton, James, D., Rotnitzky, A., Daniel, S., Shih, W.J., Siegel, J.P., Stern, H., 2012. The prevention and treatment of missing data in clinical trials. N. Engl. J. Med. 367, 1355–1360. https://doi.org/10.1056/NEJMsr1203730.

Mahalik, J.R., Coley, R.L., Lombardi, C.M.P., Lynch, A.D., Markowitz, A.J., Jaffee, S.R., 2013. Changes in health risk behaviors for males and females from early adolescence through early adulthood. Health Psychol. 32, 685–694. https://doi.org/10.1037/a0031658.

McAloney, K., Graham, H., Law, C., Platt, L., 2013. A scoping review of statistical approaches to the analysis of multiple health-related behaviours. Prev. Med. (Baltim). 56, 365–371. https://doi.org/10.1016/j.ypmed.2013.03.002.

McLaughlin, K.A., Hatzenbuehler, M.L., 2009. Mechanisms linking stressful life events and mental health problems in a prospective, community-based sample of adolescents. J. Adolesc. Health 44, 153–160. https://doi.org/10.1016/j.jadohealth.2008.06.019.

Mistry, R., McCarthy, W.J., Yancey, A.K., Lu, Y., Patel, M., 2009. Resilience and patterns of health risk behaviors in California adolescents. Prev. Med. (Baltim). 48, 291–297. https://doi.org/10.1016/j.ypmed.2008.12.013.

Mumford, E.A., Liu, W., Hair, E.C., Yu, T.C., 2013. Concurrent trajectories of BMI and mental health patterns in emerging adulthood. Soc. Sci. Med. 98, 1–7. https://doi.org/10.1016/j.socscimed.2013.08.036.

Muthén, L.K., Muthén, B.O., 1998-2017. Mplus User's Guide, Eighth edition. Muthén & Muthén, Los Angeles, CA.

Nagin, D.S., 2005. Group-Based Modeling of Development. Harvard University Press, Cambridge, MA.

Oldehinkel, A.J., Veenstra, R., Ormel, J., de Winter, A.F., Verhulst, F.C., 2006. Temperament, parenting, and depressive symptoms in a population sample of preadolescents. J. Child Psychol. Psychiatry Allied Discip. 47, 684–695. https://doi.org/10.1111/j.1469-7610.2005.01535.x.

Oldehinkel, A.J., Rosmalen, J.G.M., Buitelaar, J.K., Hoek, H.W., Ormel, J., Raven, D., Reijneveld, S.A., Veenstra, R., Verhulst, F.C., Vollebergh, W.A.M., Hartman, C.A., 2015. Cohort profile update: The tracking adolescents' individual lives survey (TRAILS). Int. J. Epidemiol. 44 https://doi.org/10.1093/ije/dyu225, 76-76n.

Pampel, F.C., Krueger, P.M., Denney, J.T., 2010. Socioeconomic disparities in health behaviors. Annu. Rev. Sociol. 36, 349–370. https://doi.org/10.1146/annurev.soc.012809.102529.

Peeters, M., Oldehinkel, A., Veenstra, R., Vollebergh, W., 2019. Unique developmental trajectories of risk behaviors in adolescence and associated outcomes in young adulthood. PLoS One 14, 1–19. https://doi.org/10.1371/journal.pone.0225088.

R Core Team, 2020. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Rosenbaum Asarnow, J., 2014. Depression and health risk behaviors: towards optimizing primary care service strategies for addressing risk. Prim. Heal. Care Open Access 04, 1–15. https://doi.org/10.4172/2167-1079.1000152.

Sagone, E., De Caroli, M.E., Falanga, R., Indiana, M.L., 2020. Resilience and perceived self-efficacy in life skills from early to late adolescence. Int. J. Adolesc. Youth 25, 882–890. https://doi.org/10.1080/02673843.2020.1771599.

Simpson, E.G., Vannucci, A., Ohannessian, C.M.C., 2018. Family functioning and adolescent internalizing symptoms: a latent profile analysis. J. Adolesc. 64, 136–145. https://doi.org/10.1016/j.adolescence.2018.02.004.

Skogen, J.C., Knudsen, A.K., Hysing, M., Wold, B., Sivertsen, B., 2016. Trajectories of alcohol use and association with symptoms of depression from early to late adolescence: the Norwegian Longitudinal Health Behaviour Study. Drug Alcohol Rev. 35, 307–316. https://doi.org/10.1111/dar.12350.

Tucker, J.S., Ellickson, P.L., Orlando, M., Martino, S.C., Klein, D.J., 2005. Substance use trajectories from early adolescence to emerging adulthood: A comparison of smoking, binge drinking, and marijuana use. J. Drug Issues 35, 307–332. https://doi.org/10.1177/002204260503500205.

van Nieuwenhuijzen, M., Junger, M., Klein Velderman, M., Wiefferink, K.H., Paulussen, T.W.G.M., Hox, J., Reijneveld, S.A., 2009. Clustering of health-compromising behavior and delinquency in adolescents and adults in the Dutch population. Prev. Med. (Baltim). 48, 572–578. https://doi.org/10.1016/j.ypmed.2009.04.008.

White, I.R., Royston, P., Wood, A.M., 2011. Multiple imputation using chained equations: issues and guidance for practice. Stat. Med. 30, 377–399. https://doi.org/10.1002/sim.4067.

Yu, J., Putnick, D.L., Hendricks, C., Bornstein, M.H., 2017. Health-risk behavior profiles and reciprocal relations with depressive symptoms from adolescence to young adulthood. J. Adolesc. Health 61, 773–778. https://doi.org/10.1016/j.jadohealth.2017.07.002.