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Health-Risk Behavior Profiles and Reciprocal Relations with Depressive Symptoms from Adolescence to Young Adulthood

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Abstract

Purpose—We examined co-occurrences of multiple health-risk behaviors among adolescents in a 5-year longitudinal design as well as their associations with mental health outcomes.

Methods—Latent transition analyses explored subgroups of adolescents ($N = 229$; 51% males) who engaged in distinct patterns of health-risk behaviors and transitions over time. Moreover, longitudinal relations between risk behavior profiles and depressive symptoms were also explored.

Results—We identified four latent profiles based on risk levels of safety & violence, sexual behavior, alcohol use, and marijuana & other drug use at both 18 years and 23 years: *Low Risk*, *Modest Risk*, *Medium Risk*, and *High Risk*. Some adolescents maintained their latent profile membership over time, but more transitioned between risk profiles. Adolescents with more depressive symptoms had a higher probability of developing into the *High Risk* versus *Low* and *Modest Risk* profiles at 23 years. Adolescents in the *High*, *Low*, and *Modest Risk* profiles at 18 years developed more depressive symptoms in young adulthood compared to *Medium Risk* adolescents.

Conclusions—This study provides a better understanding of the prevalence, distribution, and change patterns of health-risk profiles across adolescence and young adulthood in a European American sample. Reciprocal relations between high risk profiles and depressive symptoms suggest the need for integrated but tailored prevention and intervention programs.

Keywords

depressive symptoms; risk behavior profiles; latent transition analysis

Many adolescents display risk behaviors that may persist into adulthood and contribute to an enormous public health and social financial burden [1]. Young people (20%–40%) may engage in adverse, aggressive, and otherwise reckless behaviors, including driving without a

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seatbelt and bullying [2], which can threaten their own and others' physical health and safety. Moreover, adolescents and young adults have the highest age-specific diagnosis rates for many sexually transmitted diseases compared with other age groups [3]. Age-specific rates of alcohol indulgence and illicit drug use (with marijuana being the most popular drug of choice) also peak among adolescents and young adults (15%–45%) [3], which can lead to serious health consequences, such as cardiovascular disease and psychiatric disorders [4,5].

Risk behaviors have been widely studied among adolescents and young adults. However, most studies have focused on individual risk behaviors or a relatively small range of behaviors. According to Jessor's problem behavior theory, risk behaviors tend to co-occur in youth [6] perhaps because they share a common motivation of thrill seeking. Researchers have also proposed specific mechanisms to explain the covariation among risk behaviors. For instance, alcohol and marijuana use may increase the likelihood of sexual risk, reckless behavior, and violence by lowering inhibitions or diminishing an individual's ability to assess risk [3]. Given the possible co-occurrence of different risk behaviors, a better understanding of health risk among adolescents requires a more holistic approach where a broader range of risk behaviors is considered simultaneously. It is also important to investigate the clustering of health risk behaviors because individuals engaging in multiple health-risk behaviors are at the greatest risk of developing health problems [7]. Therefore, identifying profiles of co-occurring risk behaviors among adolescents can help inform the design of targeted and effective prevention and intervention strategies to promote adolescent health.

Latent Transition Analyses of Health-Risk Behaviors

In many research studies, individual or correlated risk behaviors are examined in multivariate variable-centered approaches where interactions are rarely examined due to a lack of statistical power [8]. Furthermore, high levels of multicollinearity often exist in multiple regression analyses that can mask the predictive role of important factors [8]. Applications of person-centered approaches have the potential to provide new insights into health risks to complement traditional variable-centered methods (e.g., regression). For example, higher-order interactions among multiple risk behaviors can be examined and subgroups of individuals with distinct patterns of risk behaviors can be identified, using person-centered techniques such as Latent transition analysis (LTA) used here [9].

Emerging research has applied LTA to study latent classes and transitions of risk behaviors [10,11], but most LTA studies have focused on individual risk behaviors. For example, Auerbach and Collins (2006), who examined the transition in alcohol use among individuals age 18.5 years to 22.5 years [12], found that alcohol use class memberships were largely stable, although a proportion of individuals transitioned into and out of the latent profiles between these age periods. Chuang and Martin (2005) utilized LTA to analyze the structure of diagnostic symptoms related to substance use disorders among adolescents, and identified Few or No Symptoms, Mild, and Severe latent statuses [13]. To date, little research has examined multiple risk behaviors (e.g., alcohol use, drug use, sexual behavior, violence) in longitudinal contexts as we do here. Using person-centered analysis to examine a wider

range of health-risk behaviors can offer a more nuanced and dynamic portrait of adolescents' risk profiles over time.

Health-Risk Behaviors and Depressive Symptoms

Although some risk behaviors have been shown to co-occur with mental health problems, there is no consistent theoretical argument to explain or clear-cut empirical support for the relation [14]. Some studies report that greater alcohol or drug use during adolescence might undermine adolescents' neurobiological development involving reward and self-regulation thus predicting more depression in young adulthood [15]. Other studies report that alcohol use is associated with enhanced psychological well-being, perhaps due to the instrumental use of alcohol to establish social networks [16]. Similarly, for the prediction of mental health on risk behavior, self-medication theory posits that depressed or anxious individuals use alcohol or drugs to reduce their negative emotions [17], whereas risk-avoidance theory predicts that depressed or anxious individuals are more likely to be over-controlled and isolated, and less likely to take risks [18].

Previous research has provided cross-sectional evidence for the association between depressive symptoms and individual risk behaviors. For example, depression appears to be positively associated with sexual risk-taking, physical violence, wearing seatbelts and bike-helmets less often, and alcohol and drug use [19,20]. With respect to longitudinal evidence, extant studies have not consistently confirmed that depressive symptoms predict risk behaviors [15,21]. Instead, many studies report that behavioral risk led to later increased levels of depressive symptoms. In one study on adolescents, having tried drugs or engaged in two or more health-risk behaviors (smoking, alcohol, or drug use) at baseline predicted depressive symptoms two years later [22]. Therefore, depression may be a result of adolescent risk behaviors but it is inconclusive whether depression causes engagement of risk behaviors. Moreover, evidence for relations between depressive symptoms and clusters of risk behaviors is scarce. Some cross-sectional evidence supports an association between depressive symptoms and the clustering of risk behaviors [23], but little research disentangles the direction of links between depression and risk behavior clustering [21]. Here, we extended previous research by including a wider range of risk behaviors, and we examined predictive relations between depressive symptoms and risk behavior profiles to illuminate the temporal ordering between mental and behavioral health.

The Present Study

We used LTA to identify latent subgroups of adolescents who engaged in different levels of four categories of risk behaviors, including safety and violent behavior, sexual behavior, alcohol use, and illicit drug use across late adolescence and young adulthood. In addition, we examined longitudinal associations between the risk profile memberships and development of depressive symptoms. The LTA technique and the longitudinal design allowed us to investigate the prevalence of latent profiles across a 5-year period and associated mental health outcomes. Given the lack of research or less than coherent findings in the literature, we did not have specific hypotheses for the number of latent profiles in LTA

or relations between depressive symptoms and latent profiles. Therefore, this study is exploratory in nature.

Method

Participants

European American families with healthy firstborn children were recruited through newspaper advertisements and mass mailings from the mid-Atlantic region of the United States. All data used in the current study were collected via a secure on-line website. The first assessment for this study was administered when participants were 18 years old ($M_{\text{age}} = 18.21$, $SD = 0.35$, *range* 17–19), and the second was administered 5 years later when participants were 23 years old ($M_{\text{age}} = 23.62$, $SD = 0.58$, *range* 22–25). The sample consisted of 229 adolescents (51% males). Education levels for the mothers/fathers were master's degree or above (39%/42%), bachelor's degree (35%/31%), some college (22%/16%), and high school diploma or below (5%/11%). Combined gross family incomes were less than \$74,999 (14%), \$75,000 to \$124,999 (27%), \$125,000 to \$199,999 (32%), and \$200,000 or more (28%). Informed consent was obtained from all participants who were compensated for their time. The study was approved and monitored by our institutional review board.

Measures

At both 18 and 23 years, participants self-reported risk behaviors during the past 6 months using a measure adapted from the Youth Risk Behavior Survey (YRBS) [24]. Nine items measured behaviors that contribute to unintentional injuries or *safety* (e.g., How often did you ride as a passenger without wearing a seatbelt?) and *violence* (e.g., How often did you carry a weapon (knife, gun, etc.)?). Three items measured *sexual behavior* (e.g., How often did you engage in sexual intercourse?). Three items measured *alcohol use* (e.g., How often did you have enough alcohol that you felt drunk or not your “normal” self?). Three items measured *marijuana and other drug use* (e.g., How often did you use illegal drugs (cocaine, heroin, acid, speed, etc.)?). All items were rated on either a 5-point (0 = *never*, 1 = *once*, 2 = *twice*, 3 = *3 or 4 times*, and 4 = *5 or more times*) or 6-point scale (0 = *never*, 1 = *once*, 2 = *2–4 times*, 3 = *5–10 times*, 4 = *11–19 times*, and 5 = *20+ times*). Because of the varying response scales, all items were converted to standardized scores ($M = 0$, $SD = 1$). To conduct latent transition analysis, we computed mean scores for each type of risk behavior. The risk behavior measures obtained acceptable to good internal consistency estimates (i.e., Cronbach's alphas) at 18 and 23 years, ranging from .69 to .91.

At both 18 and 23 years, participants reported their depressive symptoms using the Center for Epidemiological Studies Depression Scale (CES-D) [25], conceptualized as feelings of frustration, sadness, demoralization, loneliness, and pessimism about the future during the past week. Ten items in the short form CES-D were rated on a 4-point scale (0 = *rarely or one of the time*, 1 = *some or a little of the time*, 2 = *occasionally or a moderate amount of time*, 3 = *most or all of the time*). A composite score was used as a continuous measure of depressive symptoms, with higher scores indicating higher levels of depressive symptoms (Cronbach's alphas = .82 and .84 for 18- and 23-year data, respectively).

Data Analysis Plan

The sample had an attrition rate of 26%, and data were assumed to be missing completely at random (MCAR) as indicated by Little's (1988) MCAR test [26], $\chi^2 = 116.92$, $p = .201$. Full information maximum likelihood (FIML) estimation was used to handle missing data [27]. Two- to six-class solutions of LTA were conducted to examine how individuals' risk behavior profiles changed over the 5-year period. To systematically test whether the nature of the profiles changed over time, measurement invariance for each LTA solution was evaluated by imposing longitudinal equivalence constraints on the profile parameters. Models with measurement invariance were preferred to maintain equivalence of the latent profiles. Robust maximum likelihood estimators in *Mplus 7* [28] were used to address multivariate non-normality. We used 2,000 random sets of start values to ensure that the best log likelihood value was adequately replicated. Better model fit was determined by lower values of relative model fit statistics [29], including the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC), and the sample-adjusted BIC (SABIC). Entropy was used to assess the quality of membership classification, with values closer to 1 indicating better classification [29].

Once the measurement invariant LTA was obtained, we used the three-step procedure [30] to examine relations between auxiliary variables (depressive symptoms and background variables, including adolescent age and gender, parental age and education, and family income) and the identified latent profiles. The three-step method avoids the influence of covariates on estimating the measurement model and accounts for classification error [30]. In Step 1, we estimated latent profiles for each wave of data separately with the means of each type of risk behavior constrained to be equal across time. In Step 2, we determined the logit values for the classification probabilities for the most likely class variable N to be used in Step 3 in accounting for measurement error. In Step 3, covariates were added to the LTA model to examine the prediction of 18-year depressive symptoms on 23-year latent profiles using multinomial regressions; 23-year depression was added as a distal outcome of, and compared across, the 18-year risk profiles after controlling for adolescents' initial levels of depressive symptoms at 18 years using ANCOVA (see Figure 1 for the conceptual model).

Results

Latent Risk Profiles

LTA results are reported in Table 1. For the unconstrained LTA models (Table 1A), the values for AIC, BIC, and SABIC continued to decrease with the addition of profiles. Despite better fit indices than the solutions with fewer profiles, the five- and six-profile models contained one or more profiles that were very small in size (e.g., 1% of the total sample). For the constrained LTA models (Table 1B), there were large decreases in the AIC, BIC, and SABIC with the addition of profiles until the five-profile model. To test measurement invariance, we conducted the scaled chi-square difference test comparing all pairs of models with the same number of profiles [31]. Results showed that the scaled chi-square difference tests for two-, three-, five- and six-profile models were all statistically significant, whereas the four-profile model achieved measurement invariance (Table 1B). Therefore, the four-profile model with measurement invariance was retained as the final LTA model.

To delineate the four risk profiles, we conducted Ward tests comparing the levels of risk behavior across profiles and plotted the means of each behavioral risk (Figure 2). Profile 1 is characterized by comparatively low scores on all risk behaviors; thus, we labeled this profile *Low Risk*. This profile represents 38% of the 18-year-olds and 23% of the 23-year-olds. Profile 2 is characterized by relatively higher scores than Profile 1 on Safety & Violence, Alcohol Use, Sexual Behavior, and Marijuana & Other Drug Use; thus, we labeled it *Modest Risk*. This profile represents 44% of the 18-year-olds and 50% of the 23-year-olds. Profile 3 had higher scores on the four types of risk behaviors than both Profile 1 and 2; thus, we labeled it *Medium Risk*. Profile 3 represents 8% of the 18-year-olds and 20% of the 23-year-olds, respectively. Compared to Profile 3, Profile 4 had similar scores on Safety & Violence and Sexual Behavior, slightly higher Alcohol Use, and much higher Marijuana & Other Drug use, and thus we labeled it *High Risk*; it represents 10% of the 18-year-olds and 7% of the 23-year-olds. Based on the measurement invariant four-profile solution, we then investigated transitions in latent profile memberships across time and relations between depressive symptoms and the latent profiles.

Transition Probabilities of Latent Profiles

With four profiles at each wave, there are a total of 16 transitions as shown in the transition matrix in Table 2. Of those in the *Low Risk* group at 18 years, 52% maintained the same profile membership and 48% moved into higher risk profiles (mainly *Modest Risk*) at 23 years. Most adolescents in the *Modest Risk* group (68%) at 18 years maintained their group membership and 25% transitioned to the *Medium Risk* group at 23 years. For the *Medium Risk* group at 18 years, 22% stayed in the same profile over time, 65% moved into the *Modest Risk* profile, and 13% transitioned to the *High Risk* profile at 23 years. About 45% of the *High Risk* individuals at 18 years transitioned into the *Medium Risk* profile at 23 years, whereas 40% stayed in the *High Risk* profile at 23 years.

Relations between Depressive Symptoms and Latent Profiles

We estimated the demographic variables first and found no significant effects of adolescent age and gender, mother age, father age, highest education levels of mothers and fathers, or family income in predicting latent profiles or depressive symptoms at 23 years. Therefore, we dropped these non-significant control variables [33], which is recommended to avoid overcontrol and increase statistical power. Multinomial regressions showed that adolescents with higher levels of depressive symptoms at 18 years were more likely to be classified in the *High Risk* group versus the *Low Risk* ($b = 0.30, p = .009, 95\%CI [0.08, 0.53]$) or *Modest Risk* ($b = 0.29, p = .003, 95\%CI [0.08, 0.39]$) groups at 23 years, after controlling for their initial group memberships. ANCOVA results indicated that adolescents in the *High Risk* profile at 18 years developed more depressive symptoms at 23 years than the *Medium Risk* group ($M_{diff} = 4.35, p = .001, 95\%CI [1.99, 7.48]$), regardless of their initial levels of depressive symptoms at 18 years. Adolescents in the *Low Risk* ($M_{diff} = 3.47, p = .001, 95\%CI [1.44, 5.51]$) and *Modest Risk* ($M_{diff} = 3.24, p < .001, 95\%CI [1.72, 4.76]$) profiles at 18 years also developed higher levels of depressive symptoms at 23 years compared to the 18-year *Medium Risk* profile, which again controlled for the temporal stability of depressive symptoms.

Discussion

This study examined latent profiles of risk behaviors among adolescents and young adults over a 5-year period. Four subgroups with different patterns of risk behaviors were identified at 18 and 23 years. Although there is stability in the number and nature of the latent profiles across the two age periods, the relative proportions of adolescents in the profiles changed, indicating that many adolescents had transitioned into different profiles by young adulthood. Moreover, young adulthood risk behavior profiles were predicted by adolescents' initial levels of mental health, with a greater likelihood of multiple risk behaviors co-occurring at 23 years when adolescents experienced more depressive symptoms at 18 years. The prediction of risk profiles on the development of depressive symptoms was more complex. *High Risk* adolescents experienced more depressive symptoms at 23 years than those with medium behavioral risk; however, adolescents with low and modest behavioral risk also had more depressive symptoms than *Medium Risk* adolescents after controlling for their initial depressive symptoms.

More than one-third of adolescents (38%) engaged in very low levels of risk behavior, which decreased to 23% among 23-year-olds, indicating that young adulthood is a developmental period for experimentation with one or more risk behaviors. The *Medium Risk* groups engaged in significantly more risk behaviors than *Low* and *Modest Risk* groups, but developed even fewer depressive symptoms over time than those individuals. Adolescents in the *Medium Risk* groups might not engage in very high levels of risk behavior in an absolute sense. Moreover, they may transition from living at home with parents to living more independently elsewhere with friends or partners. Thus, some behaviors such as sexual behavior can be normative and may not always constitute a problem [34]. Alcohol drinking at parties may even be expected for adolescents to be social with their peer groups. Experimentation with substance use or sexual behavior could also be an opportunity for young adults to explore their self or identity [35,36]. It is possible that, no or extremely low levels of exploration with any risk behaviors during young adulthood may not be adaptive; Rather, adolescents with low behavioral risk may suffer other problems (e.g., social withdrawal, lack of friendship skills) that undermine their long-term mental health.

About 10% of adolescents (*High Risk*) were characterized by very high levels of all risk behaviors especially Marijuana & Other Drug use, and this percentage did not change much among 23-year-olds (7%). These adolescents are particularly concerning because they not only engaged in multiple risk behaviors but also tended to develop significantly more depressive symptoms over time, consistent with some previous studies [15,21]. Engaging in risk behaviors above a certain level may offset potential social benefits and lead to health problems. For example, high levels of alcohol and drug use may disrupt neurocognitive functioning among adolescents and increase the likelihood of developing depression by altering the brain's reward system [37]. The finding that *High Risk* adolescents tend to develop more depressive symptoms may also reflect how the nature and meaning of a specific risk behavior varies as a function of the levels of other risk behaviors within an embodied system [38]. For example, sexual behavior alone can be normative in young people, but in the context of heavy drinking and drug use it may be associated with dating

violence, unprotected sex, or other highly risky sexual activities, leading to psychological problems [35].

We found that adolescent depressive symptoms prospectively predicted young adults' *High Risk* latent profile versus *Low* and *Modest Risk* profiles, suggesting an association between higher levels of depressive symptoms and high co-occurrence or comorbidity of risk behaviors. Our findings support the theory that adolescents with depressive symptomatology may self-medicate by engaging in a variety of risk behaviors, such as sex, alcohol, and marijuana use behaviors, in an attempt to regulate their negative affect [19]. However, engaging in risk behaviors to a high degree may not be an effective way to ease psychological distress, but rather exacerbates emotional problems over time. Risk-taking is a maladaptive coping strategy that may only provide momentary distraction or relief at the cost of long-term health [39]. By way of treatment, promoting healthier coping strategies to help adolescents regulate their emotions may motivate them to depend less on alcohol, drug use, and other risky behaviors. In addition, depression may distort adolescents' perceptions of risk, impair their impulse control, and disrupt social relationships, and diminish value placed on personal health and self-protection, which in turn lead to more risk behaviors [39]. Future research should explore the mediating mechanisms underlying reciprocal relations between risk behavior and depression to provide insights about effective targets for intervention.

Our findings should be considered in light of several limitations. First, our sample is composed of relatively higher SES, non-minority families, which may not generalize to other populations. However, studies have found that high-SES or European American samples are at comparable risk for engaging in different risky behaviors [40]. More research is needed on the mental and behavioral health of adolescents from a variety of populations. Second, adolescents and young adults self-reported their risk behaviors and depressive symptoms, which may be common and appropriate, but single reporter bias may explain some associations. Finally, although we found directional relations between high behavioral risk and depressive symptoms, we cannot rule out unidentified factors that may cause both, such as low self-esteem and competence [35]. Future research is warranted to better understand the etiology of both depression and youth engagement in risk behaviors.

Despite these limitations, this study, spanning 5 years, contributes to the growing body of knowledge on adolescents' risk behaviors and mental health. A significant strength of this study is integrating the use of a person-centered approach to modeling adolescents' multiple risk behaviors in a longitudinal design and a variable-centered approach to studying the relations between depressive symptoms and latent risk profiles. The latent transition analyses allowed us to identify distinct health-risk behavior profiles and transition patterns. Regression analyses revealed reciprocal relations between engagement in multiple behavioral risks and depressive symptoms. Findings from the two approaches together suggest that individuals with high behavioral risk should be targeted for mental health interventions. Because high levels of mental and behavioral risks are intertwined, targeting one of them may effectively help the other. This study provides insights into why and how health care professionals should identify adolescents with multiple behavioral and mental

health risks and calls for additional research to understand how best to tailor interventions to improve adolescents' long-term development and health.

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Implications and Contribution

This study identified four latent profiles of adolescents with different levels of risk behavior and found reciprocal associations between a *High Risk* profile and depressive symptoms over time. Findings suggest that mental health and behavioral risks are intertwined and targeting one of the two aspects may be effective in treating the other.

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Figure 1.

The LTA Model with Covariate (18-year depressive symptoms) and Distal Outcome (23-year depressive symptoms).

Note: The two circles represent the four different latent profiles at each wave from the measurement invariant LTA model. In the third step of three-step analysis, 18-year depressive symptoms were included as a predictor of 23-year latent profiles controlling for 18-year risk profiles (see the bold lines). Differences in 23-year depressive symptoms were tested across the 18-year risk profiles after controlling for initial levels of depressive symptoms at 18 years (see the dashed lines).

Figure 2.

Latent profiles at both waves in the measurement invariant four-profile LTA model.

Percentages of each latent profile at 18 years are presented on the left side of the slash in the parentheses; percentages of the same latent profile at 23 years are presented on the right side of the slash in the parentheses. P = Profile.

Table 1

Latent Transition Analysis Models

A. Unconstrained LTA Models

<i>k</i>	LL	SCF	#fp	AIC	BIC	SABIC	Entropy
2	-1381.09	1.70	23	2808.19	2887.16	2814.27	0.87
3	-1277.71	1.56	36	2627.42	2751.03	2636.93	0.77
4	-1195.97	2.05	51	2493.94	2669.06	2507.42	0.79
5	-1121.49	1.16	68	2378.97	2612.47	2396.95	0.81
6	-1056.95	0.90	87	2287.90	2586.63	2310.89	0.82

B. Constrained LTA Models

<i>k</i>	LL	SCF	#fp	AIC	BIC	SABIC	Entropy	MI Test
2	-1393.82	1.80	15	2817.65	2869.15	2821.61	0.88	$p = .032$
3	-1305.60	1.45	24	2659.19	2741.60	2665.54	0.78	$p = .002$
4	-1235.84	1.51	35	2541.67	2661.85	2550.93	0.77	$p = .076$
5	-1174.94	1.15	48	2445.87	2610.69	2458.56	0.81	$p < .0001$
6	-1130.66	0.77	63	2387.31	2603.64	2403.97	0.83	$p < .0001$

Note: LTA = Latent Transition Analysis; k = number of latent profiles in the model; LL = model log likelihood; SCF = Scaling Correction Factor of the robust maximum likelihood estimator; #fp = number of free parameters; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; SABIC = Sample-Adjusted BIC; MI = Measurement Invariance

Table 2

Latent Transition Probabilities

		23 Years			
		Low Risk	Modest Risk	Medium Risk	High Risk
18 Years	Low Risk	.52	.40	.06	.03
	Modest Risk	.06	.68	.25	.02
	Medium Risk	.00	.65	.22	.13
	High Risk	.09	.06	.45	.40

Note: The bolded diagonal figures indicate probabilities of staying in the same profiles/statuses at 18 and 23 years, whereas the off-diagonal figures are transition probabilities from specific profiles at 18 years to specific profiles at 23 years.