Weight Control Behaviors among Emerging Adults with Type 1 Diabetes

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Abstract

Purpose: The purpose of this study was to examine the association of weight control behaviors (WCBs) with living and educational situations among emerging adults with type 1 diabetes during the first year after high school graduation.

Methods: Among 184 emerging adults with type 1 diabetes, data were collected every three months for 12 months on WCBs, body mass index (BMI), living and educational situations; at baseline and 12 months on impulse control; and at baseline on gender, depressive symptoms, and glycemic control. Generalized Linear Models incorporated repeated measures (0, 3, 6, 9, and 12 months).

Results: No significant associations existed between WCBs and living or educational situations, when controlling for covariates. More depressive symptoms and higher BMIs were associated with a greater likelihood of involvement in unhealthy WCBs whereas more depressive symptoms, and not higher BMI, were associated with higher odds for involvement in very unhealthy WCBs. Although healthy WCBs was also associated with more depressive symptoms and higher BMIs, it was also associated with greater impulse control.

Conclusions: Health care professionals should assess emerging adults with type 1 diabetes for WCBs along with BMI, depressive symptoms, and impulse control.

Weight Control Behaviors among Emerging Adults with Type 1 Diabetes

Weight control behavior (WCB) is a specific concern for youth in general,[1] including those with type 1 diabetes,[2] in the developmental period of emerging adulthood, ages 18 to 25+ years.[3] Given that youth with diabetes have concerns about their weight, leading to attempts to lose weight,[4] WCBs may be salient for non-high risk youth, such as those without a diagnosed eating disorder, which is well known to be associated with diabetes.[5] Indeed, adolescents and early emerging adults with type 1 diabetes do practice WCBs, some healthy and some not.[4,6] Up to 90% of females and 63% of males are estimated to be involved in healthy WCB such as exercising, eating fruits and vegetables, and minimizing high fat foods and sweets;[4,6] however, up to 28% of females and 7% of males are estimated to be involved in unhealthy WCB such as smoking, skipping meals, using food substitutes, eating very little and fasting, and up to 10% of females and 1% of males in very unhealthy WCB such as using diet pills, vomiting, intentionally misusing insulin, and using laxatives and diuretics.[4,6] WCBs other than healthy ones are associated with poor glycemic control.[4]

Eating behaviors occur within a social context,[7] which are especially important for WCBs among emerging adults [8] who are moving out of parental homes and enrolling in college.[3] The most recent data reports that most youth (68%) enrolled in college immediately after high school graduation, [9] and up to 55% of emerging adults live independently of parents.[10] All of these changes in the social context around eating may be especially important for emerging adults with diabetes. Prior to this age period, parents/families have been associated with healthier eating among adolescents in general [11] and, for those with diabetes, families are central to nutritional management of diabetes.[12]

Despite the importance of contexts for eating behaviors, [7] little is known about the association between WCBs and living/education situations among emerging adults with and without diabetes. There is some evidence that experiencing more major life events is associated with using more very unhealthy WCBs.[13] In addition, there is beginning evidence among emerging adults in general that living and educational contexts are associated with eating behaviors; however how these contexts influence eating behaviors is not clear. For example, one study found that those who lived independently of parents had more healthy eating behaviors than those who remained living at home;[14] another one found that those not living on campus had less healthy eating than those living on campus;[15] and a third one found that those living off campus and more frequently involved in food preparation had relatively more healthy eating behaviors than those living on campus, who were less involved in such food preparation.[16] Among emerging adults with diabetes, it is not known if living and education situations are associated with WCBs. Youth with diabetes may engage in unhealthy WCBs if their eating behaviors are disrupted by new situations such as dorm eating when in college or by unhealthy eating habits of roommates for those no longer living with their parents. However, it also might be that, because these youth are well versed in eating behaviors essential to managing diabetes, they would make less use of unhealthy WCB in these new situations. This study will address that gap in the literature, providing knowledge about WCBs in contexts salient to emerging adults with diabetes.

To understand the contribution of these contexts to WCBs, it is important to control for individual characteristics proposed to be associated with WCBs in emerging adults with diabetes.[17] One of these characteristics is depressive symptoms, known to be associated with more unhealthy WCBs among the general population of youth[18] and specifically in terms of

more frequent dieting among emerging adults.[19] Impulse control, the ability to delay

gratification so that goals can be achieved,[20] may be a particularly important factor becuase it is

not well developed during early emerging adulthood.[20] Indeed, poor impulse control is associated

with binge eating among emerging adults in general.[21] Another characteristic is body mass Index

(BMI) because higher BMIs are associated with attempts to lose weight.[4] Finally, gender is

another relevant characteristic; among youth with diabetes, males are less involved in WCBs

than females.[4,6]

To address the lack of knowledge about the association of eating contexts to WCBs

among emerging adults with diabetes, we examined associations of WCBs (healthy, unhealthy,

and very unhealthy, respectively) to living (independent or not of parents) and educational

(enrolled or not in school) situations, controlling for gender, BMI, depressive symptoms, and

impulse control among emerging adults with type 1 diabetes during the year after high school

(HS) graduation. Examination of the associaton of WCBs with living/educational situations

during the year after HS graduation would be important because this specific year has long been

known to be a critical period for adjustment [22] and when many transitional events are

experienced.[3] If these new contexts are important to WCBs, then knowledge from this study

could guide health care professionals working with youth who are moving out of parental homes

and enrolling in school.

<div align="center">**Methods**</div>

Design

This study has a longitudinal design which typically follows the same participants for a

period of time to examine changes in a variable of interest.[23] In this report, emerging adults with

type 1 diabetes were followed for 1 year after high school graduation to examine changes in the

specific behavioral outcome of WCBs. It addresses one aim of the larger parent study, which examined multiple aims related to health behaviors and outcomes, described elsewhere.[24-30]

Participants and Procedure

In the IRB-approved parent study, HS seniors with type 1 diabetes were recruited prior to graduating from HS. Brief information about the study was provided to 17-19 year-olds from outpatient diabetes care clinics in Midwestern states; 83% of those who received the information indicated interest in participating in the study. Those interested were screened for eligibility criteria, including: being 17-19 years of age, in the last 6 months of HS, diagnosed with type 1 diabetes for at least one year, able to speak and read English, living with a parent or guardian, and being without a serious psychiatric disorder or a second chronic illness interfering with independence. Youth 18 years of age or older provided consents, whereas those under 18 provided assents and parents provided consents. Of those consented/assented, 91% completed the baseline data collection, with more females than males participating ($p < .05$). Of the participants who completed baseline, only 3% were permanently lost to follow-up. Participants who sporadically missed a data collection point were not considered withdrawn. On average, 82% completed the six data collection points, which occurred every three months.

Data Collection

Web-based entry, with a paper option, was the means for collecting questionnaire data. Baseline data were collected within three months of HS graduation and every three months thereafter for one year (0, 3, 6, 9, and 12 months) for WCBs, BMI, and living/educational situations. Data on impulse control were collected at baseline and again at 12 months whereas depressive symptoms and socio-demographic variables were measured only at baseline.

Socio-demographic and Diabetes-related Information was obtained via questionnaire or medical records. Participants self-reported on gender, age, parents' marital status, and parental education level. Height and weight, obtained from medical records, were used to calculate BMI by dividing mass (kg) by height (m)^2.[31] In order to adjust for different A1c assay methods used by the various providers assessing glycemic control (A1C values), we subtracted assay-specific bias value from the College of American Pathologists [32] data from the original A1C value reported.

Independent Living from Parents and School Enrollment were study-devised items. Participants self-reported on their situations relative to living (with parents/guardian, friends, boyfriend or girlfriend, college roommate, alone, relatives, or other) and education (in vocational school, 2-year, or 4-year college). Dichotomized living situation (living independent of parents or not) and education situation (enrolled in school, broadly defined as vocational, 2-year, or 4-year college or not) variables were created from responses.

Weight Control Behaviors were measured by the Project AHEAD Questionnaire.[33] This measure assesses involvement in three categories of behaviors to control weight: 1) healthy measured by 4 WCBs (exercising, eating fruits and vegetables, and minimizing high fat foods and sweets), 2) unhealthy measured by 5 WCBs (fasting, eating little food, using food substitutes, skipping meals, and smoking cigarettes), and 3) very unhealthy measured by 6 WCBs (taking diet pills, vomiting, skipping insulin dose, taking less insulin than prescribed, using laxatives, and using diuretics). For this study, participants were asked to respond *yes* or *no* to whether they had participated in these WCBs over the past three months. Because these youth self-reported relatively low levels of unhealthy or very unhealthy WCB involvement, participation in each WCB grouping (Healthy, Unhealthy, or Very Unhealthy) was dichotomized

into either not involved or involved. Internal consistency reliability was not calculated since it is not appropriate for the structure of this measure (counts of various behaviors).

Depressive Symptoms were measured by the 21-item Beck Depression Inventory-Second Edition (BDI-II), [34] which assesses the existence and severity of depressive symptoms as defined by the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV). Participants rated their experience of each symptom over the past two weeks on a scale from 0 to 3, with scores then summed over symptoms. Scores can range from 0-63, with values of 14-19 considered mild, 20-28 moderate, and 29-63 severe. Scores were dichotomized into having depressive symptoms (score of 14 or greater) or not (score less than 14) since these participants self-reported relatively low levels of depressive symptoms. The Cronbach's alpha for depressive symptoms in this sample was .92.

Impulse Control was measured by the Impulse Control subscale of the Self-regulation Questionnaire.[35] Participants were asked to respond to 11 statements about their inhibitory control to decisions, plans, and actions, indicating the degree each one describes them from 1 (*strongly disagree*) to 5 (*strongly agree*). After reverse-scoring items reflecting lack of abilities, responses are summed for a total score with a potential range from 11-55. Higher scores reflect greater impulse control. The Cronbach's alpha coefficient was .85 in this study.

Data Analysis

Separate generalized linear mixed models (GLMM) were used to test for associations between each of the primary predictors, living independently of parents and school enrollment, and each dichotomous outcome variable (healthy, unhealthy, and unhealthy WCBs). GLMM are able to model dichotomous dependent variables, incorporate dependencies resulting from repeated measures, and utilize time-varying covariates.[36,37] The output for such analyses are

odds ratios, which is a measure of association between an exposure and an outcome, with the odds ratio representing the odds that an outcome will occur with exposure compared to the odds the outcome will occur in the absence of that exposure.[38] Thus, an odds ratio indicates the multiplicative odds of exposure to non-exposure. An odds ratio of 1 would indicate that the exposure to the specified variable did not affect the outcome; an odds ratio < 1 would indicate that the exposure to the specified variable was associated with a lower likelihood of the outcome; and an odds ratio > 1 would indicate that the exposure to the specified variable was associated with higher likelihood of the outcome.[38] In this study, the odds of the outcome involvement in WCB or not (healthy, unhealthy and very unhealthy) was examined in association to exposure to living independently of parents or not, enrollment in school or not, higher BMI, depressive symptoms or not, greater impulse control and being male or female. Both unadjusted models, incorporating only the independent living and school enrollment predictors, and adjusted models, to which were added gender, depressive symptoms, impulse control, and BMI covariates, were tested. All variables except gender and depressive symptoms were analyzed across time to see how living and college status were associated with weight control behaviors at each visit. A .05 level of significance was used. Analyses were performed using SAS v9.3.[39]

<div align="center">Results</div>

Sample Characteristics

At baseline, the 184 emerging adults who graduated from high school were, on average, 18.2 years of age ($SD = 0.44$), had been diagnosed with diabetes for 8.54 years ($SD = 3.96$), and had an adjusted A1C of 8.9% ($SD = 1.68\%$). Most of these youth were white (93.5%). There were slightly more females (56.5%) than males in the sample. About half gave themselves multiple daily insulin injections (51.6%), and the remainder (48.4%) administered their insulin

via continuous subcutaneous insulin injection (CSII). A majority of these youths' parents were currently married (61.3%), and 96% of both their mothers and fathers had a high school education or greater.

Table 1 describes the main variables of interest at each time point in the study. During the 12 months of the study, most participants (80-81%) were involved in healthy WCBs, some (25-34%) in unhealthy WCBs, and a few (3-12%) in very unhealthy WCBs. Although at study entry all were living at home and in high school, by HS graduation 4% of participants were living independently of parents and/or enrolled in school. By one year after HS graduation, 60% were living independently of parents and 83% were enrolled in school. Average BMI was 25.3 (4.1) at baseline and 25.6 (4.4) at 12-month follow-up. On average at baseline, 7.3 ($SD = 8$) depressive symptoms were reported by participants, with only a few ($n = 24$; 13.1%) meeting the criterion for having mild or greater depressive symptoms (score of 14 or greater). These youths' average impulse control score was 41.4 ($SD = 7.3$) at baseline and 41.7 ($SD = 6.5$) at 12 months (not shown in Table 1 due to not being measured at each time point).

Insert Table 1 about Here

Associations of Healthy WCBs to Living Independently/School Enrollment

Associations of healthy WCBs (whether or not involved) to independent living and school enrollment were non-significant in both the unadjusted and adjusted models. However, when variables were examined separately for independent associations, there were some significant findings. In the living independently of parents model, involvement in healthy WCBs was independently associated with higher BMI ($OR = 1.28$, 95% CI: $1.10 – 1.48$), having depressive symptoms ($OR = 1.07$, 95% CI: $1.01 – 1.13$), and greater impulse control ($OR = 1.06$; 95% CI: $1.00 – 1.12$). The odds ratios were greater than 1, indicating that involvement in

healthy WCBs among those living independently of parents was 1.28 times higher for those who had higher BMIs; 1.07 times higher for those with depressive symptoms; and 1.06 times higher for those who had greater impulse control. Similarly, in the school enrollment model, involvement in healthy WCB was independently associated with higher BMI (OR = 1.28, 95% CI: 1.11 – 1.49), having depressive symptoms (OR = 1.07, 95% CI: 1.01 – 1.13), and greater impulse control (OR = 1.06; 95% CI: 1.00 – 1.12). These odds ratios were greater than 1, indicating that involvement in healthy WCBs for participants enrolled in school was 1.28 higher for those with higher BMIs; 1.07 times higher for those with depressive symptoms; and 1.06 times higher for those who had greater impulse control. Gender was not significantly associated with involvement in healthy WCBs in either the living or school situation models.

Associations of Unhealthy WCBs to Living Independently/School Enrollment

Associations between unhealthy WCBs (whether or not involved) and, respectively, independent living and school enrollment were non-significant in both the unadjusted and adjusted models. Again, when variables were examined separately for independent associations, there were some significant findings. Involvement in unhealthy WCB was independently associated with higher BMI (OR = 1.10, 95% CI: 1.01 – 1.19) and having depressive symptoms (OR = 1.08, 95% CI: 1.04 – 1.14) in the independent living model. The odds ratios were greater than 1, indicating that involvement in unhealthy WCBs among those living independently of parents was 1.10 times higher for those who had higher BMIs and 1.08 times higher for those with depressive symptoms. Similarly, in the school enrollment model, involvement in unhealthy WCB was independently associated with higher BMI (OR = 1.09, 95% CI: 1.01 – 1.18) and having depressive symptoms (OR = 1.08, 95% CI: 1.03 – 1.13). The odds ratios were greater than 1, indicating that involvement in unhealthy WCBs for participants enrolled in school was

1.09 higher for those with higher BMIs and 1.08 times higher for those with depressive symptoms. Neither gender nor impulse control was significantly associated with involvement in unhealthy WCBs in either the living or the school situation models.

Associations of Very Unhealthy WCB to Living Independently/School Enrollment

Associations between very unhealthy WCBs (whether or not involved) and independent living, as well as school enrollment, were significant in the unadjusted models, but were attenuated in the adjusted models (gender, BMI, depressive symptoms, and impulse control) becoming non-significant. Again, when variables were examined separately for independent associations, there were some significant findings. In the living independent model, involvement in very unhealthy WCBs was independently associated, though only slightly, with having depressive symptoms ($OR = 1.06$, 95% CI: $1.01 – 1.12$). The odds ratio was greater than 1, indicating that involvement in very unhealthy WCBs among those living independently of parents was 1.06 times more likely for those who had depressive symptoms. Similarly, in the school enrollment model, involvement in very unhealthy WCB was slightly associated with having depressive symptoms ($OR = 1.07$, 95% CI: $1.01 – 1.12$). The odds ratio was greater than 1, indicating that involvement in very unhealthy WCBs among those enrolled in school was 1.07 times more likely for those who had depressive symptoms.

Discussion

The findings of this study provide a view of WCBs among the typical, rather than high risk, emerging adult with type 1 diabetes. The good news is that most of these youth (80-81%) were involved in healthy WCBs of exercising, eating fruits and vegetables, and minimizing high fat foods and sweets. However, a minority (25-34%) practice some unhealthy WCBs such as fasting, eating little food, using food substitutes, skipping meals, and smoking, and a very few

(3-12%) practice some very unhealthy WCBs such as taking diet pills, vomiting, skipping insulin doses, taking less insulin than prescribed, using laxatives, and using diuretics. These findings are consistent with others' findings among adolescents with type 1 diabetes that a high portion were involved in healthy, a lower portion in unhealthy, and an even smaller portion in very unhealthy WCBs.[4,6] However, the unhealthy and very unhealthy WCB of these youth are a concern because such behaviors are associated with poor glycemic control.[4]

Findings from this study did not support the premise that this transitional time, with its many changes, is a vulnerable time for WCBs for emerging adults with type 1 diabetes.[17] Healthy and unhealthy WCBs were not associated with their new eating contexts for youth in this study. These findings conflict with reports that living/school situations are associated with eating behaviors among emerging adults.[14-16] Perhaps the different findings are due to the fact that eating behaviors were measured in general in those studies, whereas eating behaviors were measured specific to weight control in this report. In contrast to the findings on healthy and unhealthy WCBs, emerging adults who were living independently of parents and enrolled in school were slightly more likely to be involved in very unhealthy WCBs. However, living independently of parents and enrollment in school did not contribute to the likelihood of involvement in very unhealthy WCBs beyond the influence of gender, BMI, depressive symptoms, and impulse control.

The findings suggest that involvement in unhealthy and very unhealthy WCBs is associated with certain individual risk factors among emerging adults with type 1 diabetes. More depressive symptoms and higher BMIs appear to be risk factors for greater likelihood of involvement in unhealthy WCBs. It is likely that these youth are concerned about losing weight, given their higher BMIs; this is consistent with higher BMIs associated with attempts to lose

weight.[4] In addition, these findings are in agreement with previous findings that more depressive symptoms are associated with more frequent dieting among the general population to emerging adults.[19] However, the risk factor of more depressive symptoms without higher BMIs may be especially important for identifying those at risk for the unhealthiest WCBs. In this study, depressive symptoms was the only characteristic associated with a higher odds for involvement in very unhealthy WCBs such as skipping insulin doses and taking too little insulin. Interestingly, higher BMIs were not associated with such behaviors. It is likely that these youth are dissatisfied with their body; they were involved in behaviors to lose weight even though they did not have higher BMIs. These youth may be similar to those with eating disorders, well known to be associated with depressive symptoms and dissatisfaction with one's body.[5]

Although those involved in healthy WCB also had depressive symptoms and higher BMIs, these are not considered risk factors given that healthy WCBs are positive behaviors. However, what appears to distinguish these youth from the unhealthy and very unhealthy youth is impulse control; it was the characteristic associated only with healthy WCBs. Impulse control may be a protective factor; it is likely that better impulse control is a needed to have sufficient control to eat healthy and resist temptations. Finally, gender was not associated with healthy, unhealthy, or very unhealthy WCBs, in contrast to reports that females are more involved in WCBs.[4,6]

Consideration needs to be given to the limitations of this study. The findings can be generalized only to similar populations of emerging adults with type 1 diabetes. Youth in this study were predominately White, similar to the general population of youth with type 1 diabetes,[40] and in relatively poor glycemic control, also similar to this population.[2] However, these youth may be different from the general population in that most participants in this study

had parents who were married and HS graduates. In addition, this sample was not representative of high risk youth with type 1 diabetes since those with serious mental health disorders were excluded; however, the findings do provide a view of the typical emerging adult with type 1 diabetes.

These findings have clinical implications and suggest the need for further research. Health care professionals need to assess non-high risk emerging adults with type 1 diabetes for their involvement in WCBs. Given that unhealthy ones are detrimental to glycemic control,[4] it is essential to identify even the small portion involved in them. Further, it would be important for health care professionals to reinforce involvement in healthy WCBs for those who are concerned about their weight. It would also be important for health care providers to assess emerging adults for individual risk factors such as BMI and depressive symptoms as well as protective factors such as impulse control. Further research could examine the differentiation of those involved in healthy, unhealthy and very unhealthy WCBs based upon the unique combinations of depressive symptoms, BMI and impulse control suggested in this study. In addition, research is needed on the context for WCBs for these youth beyond the superficial indices measured in this study. For example, examination of meal routines and relationships with significant others around eating, known to influence diet,[11] could provide insight into WCBs in these new eating situations after leaving home and/or enrolling in school.

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Table 1. Description of Context, WCBs, and BMI Variables at Every 3-Month Data Collection Point

Variables	HS Graduation (n=184) # (%) or M (SD)	3 Months Post (n=173) # (%)or M (SD)	6 Months Post (n=155) # (%)or M (SD)	9 Months Post (n=152) # (%)or M (SD)	12 Months Post (n=140) # (%) or M (SD)
Context					
Living Independently of Parents	7 (3.8%)	40 (23.3%)	92 (59.4%)	96 (63.2%)	83 (59.7%)
School Enrollment	8 (4.4%)	114 (65.9%)	129 (83.2%)	128 (84.2%)	116 (82.9%)
WCBs					
Healthy	148 (80.4%)	137 (79.7%)	124 (80.0%)	122 (80.3%)	112 (80.6%)
Unhealthy	63 (34.2%)	57 (33.1%)	39 (25.2%)	48 (31.6%)	43 (30.9%)
Very Unhealthy	22 (12.0%)	15 (8.7%)	5 (3.2%)	13 (8.6%)	7 (5.0%)
Covariates					
BMI	M = 25.3 (4.1)	M = 25.5 (4.2)	M = 25.7 (4.1)	M = 25.7 (3.9)	M = 25.6 (4.4)