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The Influence of Healthy Lifestyle and Health Status on Body Mass Index (BMI) in Adults

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Abstract **Background**: With growing concerns for obesity and health comes the need to better understand factors that may affect body mass index (BMI). The aim of this research was to examine the influence of healthy lifestyle factors and health status indicators on BMI in adults. **Methods**: The Montana Behavioral Risk Factor Surveillance System (BRFSS, 2020) was used for this study. Seven healthy lifestyle variables were created indicating "high risk" and included physical activity, smoking, alcohol consumption, seatbelt use, visiting a dentist, health insurance, and sleep quantity. Nine health status variables were created indicating "poor" health and included self-rated health, heart disease, stroke, cancer, lung disease, depression, arthritis, kidney disease, and diabetes. Multiple linear regression was used to examine the effect of healthy lifestyle factors and health status indicators on BMI while controlling for sociodemographic variables. **Results**: The fully adjusted healthy lifestyles model showed high risk of physical activity (slope (b) = 1.72 kg/m^2), seatbelt use (b = 1.04 kg/m^2), and sleep quantity (b = 0.92 kg/m^2) directly related and smoking (b = -2.14 kg/m^2) and alcohol consumption (b = -0.81 kg/m^2) indirectly related to BMI (all ps < .05). The healthy lifestyle factors of visiting a dentist and health insurance did not independently influence BMI. The fully adjusted health status model showed poor health status for self-rated health (b = 1.84 kg/m^2), depression (b = 1.54 kg/m^2), arthritis (b = 1.02 kg/m^2), and diabetes (b = 3.28 kg/m^2) directly related to BMI (all ps < .05). The health status indicators of heart disease, stroke, cancer, and lung disease did not independently influence BMI. Furthermore, the physical activity × diabetes status interaction was significant (p = .031) and indicated substantially greater mean BMI for those high risk for physical activity (b = 2.57 kg/m^2, p = .003) among those with poor health status for diabetes, as compared to those high risk for physical activity (b = 1.33 kg/m^2, p < .0001) among those with good health status for diabetes. **Conclusion**: This study found that several healthy lifestyle factors and health status indicators influence BMI in adults. Health promotion specialists concerned with obesity should understand the influence that each healthy lifestyle factor has on relative body weight. Physical activity programming should in particular target those who have poor health status for diabetes in Montana.

Keywords: *Body mass index (BMI), healthy lifestyles, health status, BRFSS, Montana*

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1. Introduction

Obesity has in recent years become an uncontested priority health problem both in the United States (U.S.) and worldwide [1,2]. The most commonly cited reason behind the obesity pandemic is improper caloric balance where energy intake from food exceeds energy expenditure from physical activity [3]. Other factors, however, may influence this energy balance either directly or indirectly. For example, certain risky lifestyle factors may reinforce or enable other health risk behaviors like physical inactivity and thus in combination cause weight gain [4]. Additionally, certain health conditions may cause individuals to refrain from healthy lifestyle behaviors like physical activity, and in turn, cause weight gain [5,6]. Moreover, other health conditions may directly cause weight gain by slowing the metabolic rate regardless of the adopted health behaviors [7].

Body mass index (BMI) is the most prevalent measure of body composition due, in part, to its simplicity [8]. BMI is computed as body mass in kilograms (kg) over height in meters squared (m^2), thus BMI = kg/m^2. Weight status classification in adults can easily be determined with BMI using the following criteria: underweight (< 18.5 kg/m^2), normal weight (18.5 kg/m^2 to < 25 kg/m^2), overweight (25.0 kg/m^2 to < 30.0 kg/m^2), and obese (>= 30 kg/m^2) [9]. Many studies have explored various associations between obesity and health behaviors and conditions [10,11]. However, few studies have examined the extent to which these behaviors and conditions affect actual BMI values in U.S. adult populations. Therefore, the aim of this research was to examine the influence of healthy lifestyle factors and health status indicators on BMI in adults.

2. Materials & Methods

The Behavioral Risk Factor Surveillance System (BRFSS, 2020) was used for this research and methodological details can be found elsewhere [12,13]. Briefly, the BRFSS is a state-based annual telephone survey designed to collect data on health status and health risk behaviors that lead to premature morbidity and mortality. The BRFSS samples noninstitutionalized U.S. adults 18 years of age and older. The Montana BRFSS data only were used for this study.

Seven different binary ("high risk" vs. "low risk") healthy lifestyle variables were created and used as independent variables. A physical activity variable was created from a question asking participants if they did any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise. Participants who reported "no" were considered "high risk" for physical activity. A smoking variable was created from questions asking participants if they smoked at least 100 cigarettes in their entire life and if they currently smoke every day, some days, or not at all. Participants reporting having ever smoked 100+ cigarettes and reporting currently smoking every day or some days were considered "high risk" for smoking. An alcohol consumption variable was created from questions asking participants how many days per week they consumed alcohol and how many drinks per occasion they consumed alcohol on average (in the previous 30 days). Participants who reported having more than 14 drinks per week (males) or who reported having more than 7 drinks per week (females) were considered "high risk" for alcohol consumption. A seatbelt use variable was created from a question asking participants how often they use seatbelts when in a car. Participants who reported anything less than "always" (i.e., "nearly always" to "never") were considered "high risk" for seatbelt use. A dental visit variable was created from a question asking participants how long it had been since they last visited a dentist or a dental clinic for any reason. Participants who reported anything more than 12 months (1 year) were considered "high risk" for dental visit. A health insurance variable was created from a question asking participants if they had any kind of health care coverage. Participants who reported "no" were considered "high risk" for health insurance. A sleep quantity variable was created from a question asking participants how many hours of sleep they usually get in a 24-hour period. Participants who reported less than 7 hours were considered "high risk" for sleep quantity.

Nine different binary ("poor" vs. "good") health status variables were created and used as a separate set of independent variables. Self-rated health was assessed from a question asking participants how they rate their health in general. Participants who reported "fair" or "poor" were considered "poor" for self-rated health status. The other health status variables were assessed from a series of questions asking participants if a doctor, nurse, or other health professional ever told them that they had any of the following. Participants who reported "yes" to either heart disease, stroke, cancer, lung disease, depression, arthritis, kidney disease, and diabetes were considered "poor" for that respective health status indicator. Study covariates included sex, age, race/ethnicity, income, education, marital status, and rural/urban status.

Statistical analyses included means, standard errors (SEs) and 95% confidence intervals (CIs) for BMI across each healthy lifestyle factor and health status indicator. Test for difference in means were employed using regression analysis t statistics. Multiple linear regression was used to estimate the mean BMI difference (unstandardized slope) for all independent variables in separate models as well as in one combined model. All multiple regression models were controlled for sex, age, race/ethnicity, income, education, marital status, and rural/urban status. Analyses were weighted to produce generalizations representative of noninstitutionalized adults in Montana. SAS version 9.4 and SPSS version 27 were used for all analyses [14,15,16,17].

3. Results

A total of N = 5,852 participants had complete BMI data and pairwise deletion was used for all analyses. Table 1 contains BMI comparisons of "high risk" versus "low risk" healthy lifestyle factors. These data indicate significant mean BMI difference for all healthy lifestyle factors except health insurance. Specifically, high risk physical activity, seatbelt use, dental visit, and sleep quantity had significantly greater mean BMI, compared to low risk counterparts. While high risk smoking and alcohol consumption each had significantly lower mean BMI, compared to their low risk counterparts. Table 2 contains BMI comparisons of "poor" versus "good" health status indicators. These data show significant mean BMI difference for all health status indicators except cancer. Furthermore, all poor health status groups had significantly greater mean BMI, compared to their low risk counterparts.

Table 3 contains multiple linear regression analyses for BMI regressed on separate and combined healthy lifestyle factors. The fully adjusted combined healthy lifestyles model showed high risk of physical activity (slope (b) = 1.72 kg/m^2), seatbelt use (b = 1.04 kg/m^2), and sleep quantity (b = 0.92 kg/m^2) directly related and smoking (b = -2.14 kg/m^2) and alcohol consumption (b = -0.81 kg/m^2) indirectly related to BMI (all ps < .05). The healthy lifestyle factors of visiting a dentist and health insurance did not independently influence BMI. Table 4 contains multiple linear regression analyses for BMI regressed on separate and combined health status indicators. The fully adjusted combined health status model showed poor health status for self-rated health (b = 1.84 kg/m^2), depression (b = 1.54 kg/m^2), arthritis (b = 1.02 kg/m^2), and diabetes (b = 3.28 kg/m^2) directly related to BMI (all ps < .05). The health status indicators of heart disease, stroke, cancer, and lung disease did not independently influence BMI.

Figure 1 displays mean BMI by physical activity and diabetes status with a significant (p = .031) physical activity × diabetes status interaction. This graph indicates substantially greater adjusted mean BMI for those high risk for physical activity (b = 2.57 kg/m^2, p = .003) among those with poor health status for diabetes, as compared to those high risk for physical activity (b = 1.33 kg/m^2, p < .0001) among those with good health status for diabetes.

Table 1. Body mass index (BMI) comparison of healthy lifestyle factors in Montana adults, 2020

	High Risk lifestyle					Low Risk lifestyle					High - Low Diff	
Lifestyle factor	*N*	*Mean*	*SE*	*LL*	*UL*	*N*	*Mean*	*SE*	*LL*	*UL*	*Mean*	*p*
Physical activity	1,175	29.49	0.27	28.97	30.02	4,669	27.36	0.10	27.15	27.56	**2.14**	< .0001
Smoking	849	27.02	0.28	26.47	27.56	4,922	27.92	0.11	27.72	28.13	**-0.90**	.0023
Alcohol consumption	501	26.96	0.32	26.33	27.59	5,189	27.89	0.11	27.68	28.09	**-0.93**	.0061
Seatbelt use	1,457	28.72	0.23	28.27	29.17	4,294	27.46	0.11	27.25	27.67	**1.26**	< .0001
Dental visit	1,964	28.13	0.17	27.79	28.46	3,854	27.55	0.12	27.31	27.78	**0.58**	.0059
Health insurance	419	27.50	0.37	26.78	28.23	5,409	27.79	0.10	27.59	27.99	-0.28	.4598
Sleep quantity	1,600	28.37	0.19	27.99	28.75	4,199	27.48	0.12	27.25	27.70	**0.90**	< .0001

Note. Body mass index (BMI) computed from self-reported height and weight (kg/m^2). Mean differences in bold are significant ($p < .05$).

Table 2. Body mass index (BMI) comparison of health status indicators in Montana adults, 2020

	Poor Health Status					Good Health Status					Poor - Good Diff	
Health indicator	*N*	*Mean*	*SE*	*LL*	*UL*	*N*	*Mean*	*SE*	*LL*	*UL*	*Mean*	*p*
Self-rated health	775	30.48	0.38	29.75	31.22	5,067	27.37	0.10	27.18	27.56	**3.11**	< .0001
Heart disease	464	29.05	0.42	28.22	29.87	5,342	27.67	0.10	27.47	27.87	**1.38**	.0015
Stroke	193	29.10	0.67	27.79	30.41	5,647	27.72	0.10	27.52	27.91	**1.38**	.0411
Cancer	977	28.02	0.25	27.53	28.50	4,846	27.72	0.11	27.51	27.93	0.30	.2770
Lung disease	427	29.26	0.47	28.34	30.18	5,400	27.64	0.10	27.44	27.83	**1.62**	.0007
Depression	1,217	29.04	0.25	28.54	29.54	4,610	27.38	0.10	27.18	27.59	**1.66**	< .0001
Arthritis	1,838	29.21	0.21	28.81	29.62	3,992	27.23	0.11	27.02	27.45	**1.98**	< .0001
Kidney disease	177	29.82	0.68	28.50	31.15	5,664	27.70	0.10	27.50	27.89	**2.12**	.0019
Diabetes	655	31.96	0.38	31.22	32.70	5,192	27.33	0.10	27.14	27.53	**4.63**	< .0001

Note. Body mass index (BMI) computed from self-reported height and weight (kg/m^2). Mean differences in bold are significant ($p < .05$).

Table 3. Body mass index (BMI) regressed on separate and combined healthy lifestyle factors in Montana adults, 2020

	Separate Healthy lifestyle factor Models					Combined Healthy lifestyle factors Model			
High risk lifestyle factor	*N*	*Slope (b)*	*SE*	*t*	*p*	*Slope (b)*	*SE*	*t*	*p*
Physical activity	5,040	**1.76**	0.31	5.64	< .0001	**1.72**	0.31	5.49	< .0001
Smoking	4,991	**-1.90**	0.32	-6.00	< .0001	**-2.14**	0.32	-6.72	< .0001
Alcohol consumption	4,936	**-1.05**	0.31	-3.42	.0006	**-0.81**	0.31	-2.60	.0093
Seatbelt use	4,970	**1.02**	0.27	3.85	.0001	**1.04**	0.27	3.87	.0001
Visiting a dentist	5,022	0.36	0.24	1.49	.1360	0.41	0.24	1.72	.0852
Health insurance	5,032	-0.57	0.38	-1.50	.1343	-0.60	0.39	-1.54	.1244
Sleep quantity	5,008	**0.91**	0.24	3.80	.0001	**0.92**	0.24	3.81	.0001

Note. N = 4,830 for combined healthy lifestyle factors model. Body mass index (BMI) computed from self-reported height and weight (kg/m^2). All models controlled for sex, age, race/ethnicity, income, education, marital status, and rural/urban status. Slope values in bold are significant ($p < .05$).

Table 4. Body mass index (BMI) regressed on separate and combined health status indicators in Montana adults, 2020

	Separate Health Status Indicator Models					Multiple Health Status Indicators Model			
Poor health status indicator	*N*	*Slope (b)*	*SE*	*t*	*p*	*Slope (b)*	*SE*	*t*	*p*
Self-rated health	5,041	**2.78**	0.41	6.81	<.0001	**1.84**	0.46	4.02	< .0001
Heart disease	5,011	**0.91**	0.39	2.35	.0190	-0.10	0.41	-0.24	.8092
Stroke	5,037	0.80	0.74	1.08	.2795	-0.11	0.67	-0.16	.8734
Cancer	5,022	-0.11	0.27	-0.41	.6806	-0.49	0.28	-1.77	.0774
Lung disease	5,030	**1.21**	0.51	2.38	.0176	0.21	0.50	0.42	.6744
Depression	5,027	**1.98**	0.29	6.91	<.0001	**1.54**	0.29	5.27	< .0001
Arthritis	5,032	**1.72**	0.27	6.47	<.0001	**1.02**	0.26	4.01	< .0001
Kidney disease	5,037	**2.14**	0.79	2.71	.0068	0.54	0.85	0.64	.5232
Diabetes	5,042	**3.87**	0.41	9.52	<.0001	**3.28**	0.43	7.65	< .0001

Note. N = 4,926 for multiple health status indicators model. Body mass index (BMI) computed from self-reported height and weight (kg/m^2). All models controlled for sex, age, race/ethnicity, income, education, marital status, and rural/urban status. Slope values in bold are significant ($p < .05$).

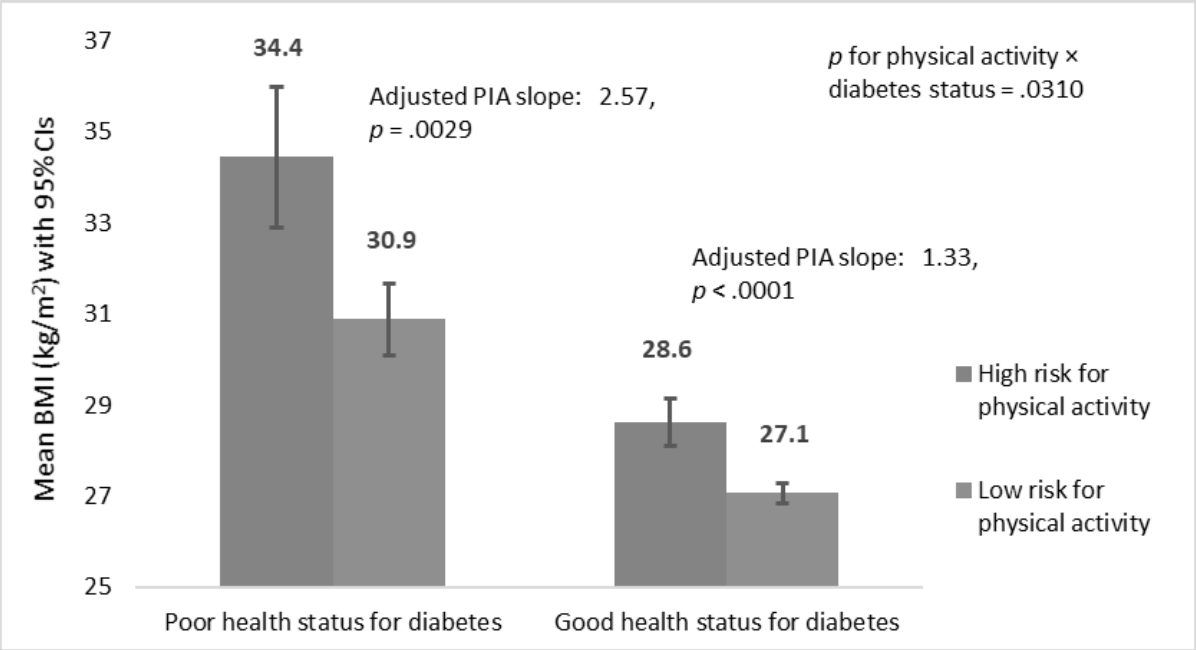

Figure 1. Mean BMI by physical activity and diabetes status in Montana adults, 2020 (Note. *N* = 5,839 (unadjusted). *N* = 5,037 (adjusted). Body mass index (BMI) computed from self-reported height and weight (kg/m^2). Adjusted slopes are controlled for sex, age, race/ethnicity, income, education, marital status, and rural/urban status)

4. Discussion

The purpose of this study was to examine the influence of healthy lifestyle factors and health status indicators on BMI in adults. Results clearly indicate multiple associations with BMI. Although some of these relationships have been confirmed by other studies, few have included multiple lifestyle factors and multiple health status indicators while examining their independent effects on BMI in adults [18,19]. Furthermore, results from the fully adjusted healthy lifestyles model, controlling for all lifestyle factors and all sociodemographic variables, showed that five factors had independent and large effects on BMI. With high risk seatbelt use and sleep quantity each associated with an approximate 1.0 BMI unit increase, high risk physical activity associated with an approximate 1.7 BMI unit increase, high risk alcohol consumption associated with an approximate 0.8 BMI unit decrease, and high risk smoking associated with an approximate 2.0 BMI unit decrease. These independent results highlight the important influence that healthy behaviors have on body composition. And especially underscore that the largest healthy lifestyle effect on BMI was a negative effect, albeit corroborated by others [20].

Similarly, results from the fully adjusted health status model, controlling for all health status indicators and all sociodemographic variables, showed that four indictors had independent and large effects on BMI (all > 1.0 BMI unit). The most noteworthy of the health status effects was that for poor diabetes health status with an approximate 3.3 BMI unit increase. Again, this large diabetes effect on BMI becomes particularly unique, unlike other studies, due to its independent influence after controlling for all other health status factors and sociodemographic variables [21].

A study strength here is the use of a current (2020) and representative sample of noninstitutionalized adults in Montana. As well, the large number of variables assessed by the BRFSS allowed for a more thorough investigation in the healthy lifestyle and health status effects on BMI, as compared to other studies. The most important limitation worth disclosing is that the BRFSS is a cross-sectional survey. Therefore, cause-and-effect associations are not possible in this study and findings should be considered correlational only. Lastly, all BRFSS variables are assessed by trained interviewers and self-reported by the participants. Therefore, certain error in the self-reporting process cannot be ruled out. Therefore, results from this research should be considered with prudence.

5. Conclusions

This study found that several healthy lifestyle factors and health status indicators influence BMI in adults. Health promotion specialists concerned with obesity should understand the influence that each healthy lifestyle factor has on relative body weight. Physical activity programming should in particular target those who have poor health status for diabetes in Montana.

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