5-2022

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Weight Gain Trajectory Over Five Years for Adult Primary Care Patients in Nebraska

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May 4, 2022

Abstract

INTRODUCTION: The continued rise in the prevalence of adult obesity in the United States is a public health concern. Several studies have identified the increasing rates of obesity, its impacts, and the factors leading to obesity. Some researchers have made obesity prevalence projections at the national and state levels. This study aims to fill the critical gap in real-time weight data trends among primary care adult patients in Nebraska. The main goal of this study is to determine and analyze the weight trajectory of adults in Nebraska over the past five years and determine if the trends vary among age and gender and if the COVID-19 pandemic impacted weight trajectory. Additionally, this study will compare the collected data to the national obesity prevalence and other researchers' obesity prevalence projections at the national and state level.

METHODS: A retrospective cohort study using un-identified data extracted from Nebraska Medicine's electronic health record sub-database was utilized to examine adult obesity prevalence based on weights and heights recorded during medical encounters. A sample of 16,507 adults had data recorded for 390,789 unique encounters. The study utilized simple descriptive statistics to calculate frequencies/percentages and means/standard deviations to determine the current prevalence of adult obesity in Nebraska to compare to the national prevalence and other researchers' prevalence predictions.

RESULTS: The average BMI of the study sample (n=16,507) was 30.6 (SD=7.1). The current obesity prevalence among our study sample is 47.6% for overall obesity (BMI $\geq$ 30) and 24.0% for severe obesity (BMI $\geq$ 35). The overall obesity prevalence is 47.9% among females and 47.1% among males. The prevalence of severe obesity is 26.8% among females and 19.9% among males. From January 2017 to October 2021, the average BMI among females and males increased among individuals aged 20 to 49, with females experiencing a larger increase in BMI.

Weight loss occurred among both females and males aged 50 years and older. Individuals aged 40-49 years had the highest BMI among females and males.

CONCLUSION: This study provides real-time weight trend data among the Nebraska adult population, including the current prevalence of overall and severe obesity. The obesity prevalence in Nebraska continues to move further away from the Healthy People 2030 goal of 36.0% and is close to reaching and exceeding 2030 obesity prevalence research projections, highlighting the importance and critical need for public health interventions to reduce obesity among adults in Nebraska.

Table of Contents

Introduction

The rising prevalence of overweight and obese adults in the United States is a public health concern. Despite the Healthy People 2030 objective of reducing obesity (*Overweight and Obesity- Healthy People 2030,* n.d.), the prevalence of obesity continues to rise year after year. In 2018, the age-adjusted prevalence of obesity among U.S. adults was 42.4% (Hales et al., 2020), and by 2030, 81.0% of adult males and 74.9% of adult females are projected to be overweight or obese (Wang et al., 2020). These projections are alarming and would result in a doubling of obesity rates in just 12 years. In Nebraska, the self-reported obesity prevalence was 34.0% in 2020 (*New Adult Obesity Maps,* 2021). Based on data gathered for a national health population survey, weight gain among the Nebraska adult population is projected to reach an obesity prevalence of greater than 50% by 2030 (Ward et al., 2019).

Obesity is a health disease defined by having an excess amount of body fat and is classified in terms of Body Mass Index (BMI), which measures weight related to height. Overweight is defined as having a BMI from 25.0 to 29.9 kg/ m^{2,} and obesity is defined as having a BMI $\geq$ 30.0 kg/m^2. Further, obesity is subdivided into classes, where class 1 is a BMI of 30-34.9 kg/m^2, class 2 is a BMI of 35-39.9 kg/m^2, and class 3 is a BMI of $\geq$ 40.0 kg/m^2 (CDC, 2021).

Obesity is a multi-factorial disease process, and there is not one exact cause of obesity. Obesity has been linked to various factors, including biologic, psychosocial, and behavioral, including genetic makeup, socioeconomic status, and cultural influences (Apovian, 2020). Further, the rising prevalence of obesity is largely related to lifestyle behaviors, such as physical activity, inactivity, dietary patterns, medication use, and other exposures. Additional factors impacting the rising rates of obesity may include an individual's physical environment,

education, skills, and food marketing and promotion (Dombrowski et al., 2012; *Adult Obesity Causes & Consequences, 2021*).

Keeping in mind that behaviors such as regular physical activity and healthy eating are vital in preventing and reducing obesity rates, researchers have begun to investigate the impact of the COVID-19 pandemic on weight gain and obesity (Lin et al., 2021). On March 11, 2020, the World Health Organization declared COVID-19 a global pandemic. To curb the spread of the disease, many states and cities issued stay-at-home orders and quarantine recommendations. It is known that social distancing measures implemented during the COVID-19 pandemic led to significant changes in many Americans' lifestyles (Lin et al., 2021). Such social distancing measures lead to changed eating habits, high levels of stress and fear, and decreased physical activity due to the closure of schools, gyms, and parks and people working from home (Aghili et al., 2021). Although few studies have thoroughly investigated the impact that COVID-19 had on weight and weight-related behaviors, it is thought that the effects may be substantial (Lin et al., 2021).

As the prevalence of obesity rises, so do the physical, mental, and social impacts experienced from obesity. Obesity is known to be a significant risk factor for morbidity and mortality from multiple diseases such as type 2 diabetes, hypertension, coronary heart disease, cerebrovascular disease, stroke, osteoarthritis, chronic musculoskeletal pain, and many types of cancer (Perreault & Laferrere, 2020; Li et al., 2015; Guh et al., 2009; Engin, 2017; Seravalle & Grassi, 2017; Mitchell et al., 2015; Oliveria et al., 2020; De Pergola & Silvestris, 2013). Some of the comorbidities mentioned are the top leading causes of death in the U.S. and worldwide, including diabetes, heart disease, stroke, and some types of cancer, highlighting the importance of reducing obesity rates (*Adult Obesity Causes & Consequences, 2021*). In addition to the

physical comorbidities associated with obesity, obesity has mental health impacts such as depression, low self-esteem, mood disorders, discrimination, and social bias (Avila et al., 2015; Taylor et al., 2013). Overall, the physical, mental, and social impacts of obesity lead to a decreased quality of life due to reduced overall functional capacity (Taylor et al., 2013). One study found that individuals with severe obesity spent most of their time participating in daily living activities and less time in work and recreational activities when compared to the non-obese population (Forhan et al., 2011). Decreased participation in such activities leads to an increased risk for mental health disorders such as depression, leading to decreased nutritional intake and physical activity, ultimately compounding multiple negative impacts of obesity (Taylor et al., 2013).

The increase in the prevalence of obesity has and will continue to have significant cost implications for the healthcare system, and there is a consensus among researchers that as BMI rises, so too does the direct healthcare costs and indirect costs (Dee et al., 2014; *Adult Obesity Causes & Consequences, 2021*). Direct medical costs may include preventive, diagnostic, and treatment services. In contrast, indirect costs relate to sickness and death and include lost productivity, such as being absent from work, decreased productivity while at work, disability, and premature death (*Adult Obesity Causes & Consequences, 2021*). The estimated annual medical cost of obesity in the U.S. was $147 billion in 2008, and the medical cost for obese individuals was $1,429 higher than those of normal weight (Hales et al., 2020). Other researchers report that annual spending related to obesity and its associated comorbidities was estimated at $315.8 billion in 2010, accounting for 27.5% of U.S. healthcare expenditures (Cawley et al., 2015). Additionally, costs related to being overweight or obese are projected to reach $861 billion in 2030 (Wang et al., 2008). As of 2010, overweight and obesity were estimated to cause

3.4 million deaths, 4% years of life lost, and 4% of disability-adjusted life-years (DALYs) worldwide (Ng et al., 2014).

Several studies have identified the increasing rates of obesity, its impacts, and the factors leading to obesity. Although some studies have even made obesity prevalence projections on the national and state level (Ward et al., 2019 & Wang et al., 2020), no study to our knowledge has collected and analyzed real-time population weight data within the Nebraska population. Our study intends to fill the critical gap in real-time weight data trends among primary care adult patients in Nebraska. Additionally, this study intends to collect and analyze Nebraska-specific weight data during the COVID-19 pandemic and discuss potential weight trends associated with the COVID-19 pandemic. We anticipate that our findings will be utilized to educate the public and healthcare providers on the current state of obesity and recent weight trends among the Nebraska adult population. Further, our research findings will provide healthcare providers and educators with real-time data to base obesity reduction and prevention strategies, programs, and interventions.

This research study aims to determine and analyze the weight trajectory of non-pregnant adults in Nebraska over the past five years and weight changes during the COVID-19 pandemic. Secondly, we will examine the collected data to determine if weight trends vary among age and/or gender. Third, this research study will compare the collected data to the national obesity prevalence and compare the data to researchers' obesity projections at the national and state level (Ward et al., 2019 & Wang et al., 2020). We aim to answer the following research questions:

1. Has weight gain occurred over the past five years within the Nebraska adult population?

2. Was there a significant change in weight during the COVID-19 pandemic among the Nebraska adult population?

3. Do the weight trends in the past five years vary by age and or gender?

4. How do the weight trends in the past five years compare to the current national obesity prevalence other researchers' obesity prevalence projections on the national and state level (Hales et al., 2020 & Ward et al., 2019)?

Methods

We conducted a retrospective cohort study using Nebraska Medicine electronic health record data extracted from EPIC. Living, non-pregnant adults aged 19 years and above were included if they had at least two weight measurements recorded in their electronic medical record between January 1, 2017, and October 31, 2021, with one weight measurement being taken in January 2017, and were a patient seen at a Nebraska Medicine family medicine clinic. The sample size for this study was 16,507, with 390,789 unique encounters. Demographics for each patient were also extracted from the Nebraska Medicine electronic health record, including age, gender, ethnicity, race, and COVID-19 diagnosis during the study time. Participant age was grouped into 20 to 29 years, 30 to 39 years, 40 to 49 years, 50 to 59 years, 60 to 69 years, 70 to 79 years, and 80 years and older. For those patients with missing heights in their medical records, we used the average height for females or males. Additionally, some patients had multiple weight measurements recorded on the same day, of which we took an average of those heights.

The extracted data were analyzed using simple descriptive statistics, where we calculated the frequencies and percentages of the patient demographics and prevalence of adult obesity for overall, females, and males. Average BMI was calculated for each age group for both females and males. The data was extracted from a de-identified sub-database from EPIC, UNMC's

Clinical Research Analytics Environment (CRANE), removing all PHI identifiers. The study did not restrict race or ethnic origin and did not include any vulnerable subjects. The research data was stored securely on UNMC's OneDrive for Business.

Results

A total of 390,789 weight measurements from 16,507 unique individuals were extracted from Nebraska Medicine EPIC sub-database, with a mean of 23 weight measurements per individual. Of the 16,507 individuals with a mean age of 54.3 years (SD = 17.1), 9,852 (59.7%) were female and 6,653 (40.3%) were male. The average BMI was 30.6 (SD = 7.1). Demographic characteristics of the study sample are presented in Table 1. The study sample was 59.7% female and 40.3% male. Adults aged 20 to 29 years of age made up 9.4% of the sample, 12.1% were 30 to 39 years of age, 15.1% were 40 to 49 years of age, 21.1% were 50 to 59 years of age, 22.0% were 60 to 69 years of age, 13.2% were 70 to 79 years of age, and 6.4% were 80 years of age or older. The majority of the sample was White (80.9%), followed by Black or African American (12.4%). Other races made up 3.2% of the sample, while 3.4% of the sample's race was unknown. The majority of the sample was non-Hispanic (95.6%), and 7.1% of the sample had a COVID-19 diagnosis documented in their EHR during the study period.

Table 1. Demographic characteristics of Study Sample (n=16,507)

Variable	Characteristics	Frequency (n=16,507)	Percent
Age	20-29	1550	9.4
	30-39	1996	12.1
	40-49	2491	15.1
	50-59	3488	21.1
	60-69	3637	22.0
	70-79	2176	13.2
	80+	1051	6.4
Sex	Female	9852	59.7
	Male	6653	40.3
Race	American Indian or Alaska Native	98	0.6
	Asian	232	1.4
	Black or African American	2039	12.4
	Native Hawaiian or Other Pacific Islander	40	0.2
	White	13361	80.9
	Multi-race	171	1.0
	Unknown[a]	566	3.4
Ethnicity	Hispanic or Latino	678	4.1
	Not Hispanic or Latino	15782	95.6
	Unknown[*]	47	0.3
COVID-19 diagnosis[b]	Yes	1165	7.1
	No	15342	92.9

[a] Unknown = designation for patients who did not have demographic data available in their chart
[b] COVID-19 diagnosis recorded in patient's chart anytime throughout the study period

The current obesity prevalence among our study sample is 47.6% for overall obesity (BMI ≥ 30) and 24.0% for severe obesity (BMI ≥ 35). The overall obesity (BMI ≥ 30) prevalence is 47.9% among females and 47.1% among males. The severe obesity (BMI ≥ 35) prevalence is 26.8% among females and 19.9% a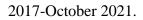mong males. These findings are presented in Table 2. Figures 1 and 2 demonstrate the prevalence of overweight and obesity of females and males by age group throughout the study period.
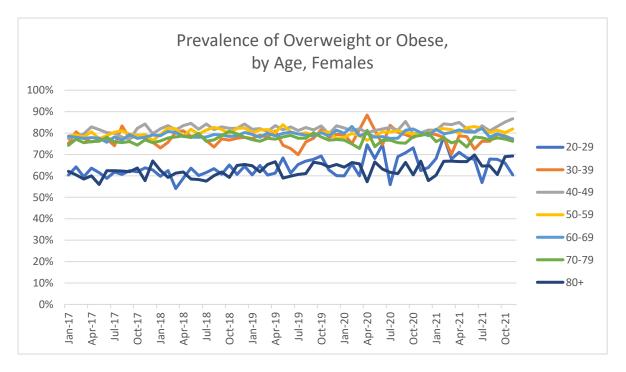
Table 2. Prevalence of Adult Obesity and Severe Obesity in October 2021

Obesity Class	Sex	Percentage (95% CI)
Overall Obesity (BMI, ≥ 30)	Overall	47.6 (46.8-48.3)
	Female	47.9 (46.9-48.9)
	Male	47.1 (45.9-48.3)
Severe Obesity (BMI, ≥ 35)	Overall	24.0 (23.4-24.7)
	Female	26.8 (25.9-27.7)
	Male	19.9 (19.0-20.9)

Figure 1. Percentage of females classified as overweight or obese by age group from January 2017-October 2021.
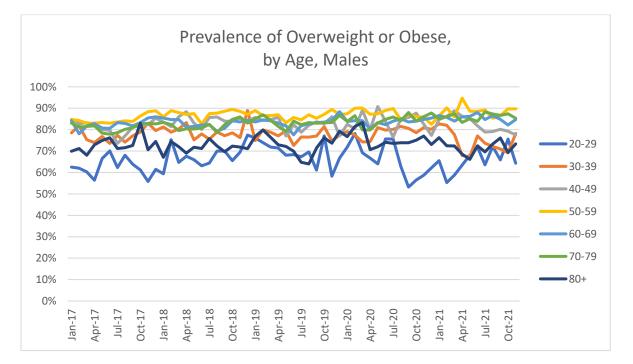
Figure 2. Percentage of males classified as overweight or obese by age group from January 2017-October 2021.

Table 3 further displays the weight changes that occurred throughout the 5-year study period by age for females and males. From January 2017 to October 2021, the average BMI among females increased among the following age groups: 20-29 by 1.24%, 30-39 by 0.65%, and 40-49 by 0.41%. The average BMI among females decreased among the following age groups: 50-59 by 0.14%, 60-69 by 0.36%, 70-79 by 0.83%, and 80+ by 0.95%. From January 2017 to October 2021, the average BMI among males increased among the following age groups: 20-29 by 0.68%, 30-39 by 0.21%, and 40-49% by 0.09%. Figures 3 and 4 display the average BMI among females and males by age group throughout the study period.

Table 3. Weight Changes in Adults Over five years, January 2017 – October 2021

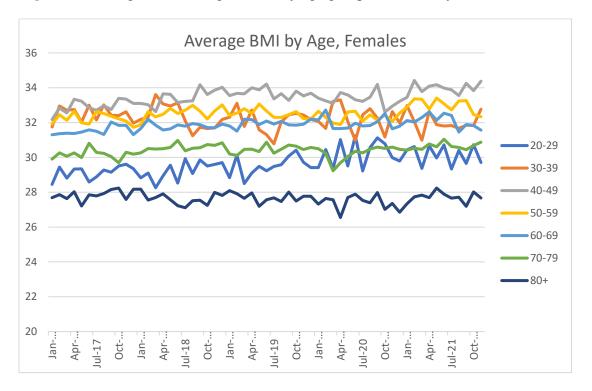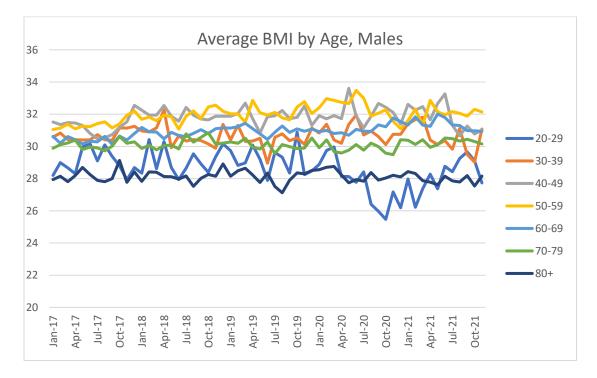| Sex	Age group	Start	End	Change (95% CI)	Number of weeks between first and last visit, mean (SD)
Average BMI for age, mean (SD)					
Female	20-29	28.24 (7.17)	29.48 (7.60)	1.24 (1.03 to 1.46)	170 (82)
	30-39	31.49 (8.36)	32.14 (8.44)	0.65 (0.43 to 0.86)	184 (80)
	40-49	32.03 (8.36)	32.44 (8.36)	0.41 (0.22 to 0.60)	197 (73)
	50-59	31.87 (7.75)	31.74 (7.84)	-0.14 (-0.30 to 0.02)	203 (70)
	60-69	31.32 (7.51)	30.96 (7.55)	-0.36 (-0.50 to -0.21)	204 (71)
	70-79	29.85 (6.58)	29.02 (6.53)	-0.83 (-1.01 to -0.66)	202 (72)
	80+	27.62 (5.77)	26.67 (5.61)	-0.95 (-1.17 to -0.73)	169 (82)
Male	20-29	28.09 (6.46)	28.77 (6.54)	0.68 (0.44 to 0.92)	164 (82)
	30-39	30.52 (6.75)	30.73 (6.90)	0.21 (-0.01 to 0.43)	177 (80)
	40-49	31.63 (6.48)	31.71 (6.61)	0.09 (-0.10 to 0.27)	188 (77)
	50-59	31.02 (6.21)	30.97 (6.49)	-0.05 (-0.22 to 0.12)	202 (70)
	60-69	30.74 (5.88)	30.17 (6.06)	-0.57 (-0.72 to -0.42)	203 (71)
	70-79	29.91 (5.28)	29.02 (5.34)	-0.89 (-1.07 to -0.71)	196 (76)
	80+	27.87 (4.74)	26.94 (4.80)	-0.94 (-1.18 to -0.69)	154 (88)

Figure 3. Average BMI among females by age group from January 2017 - October 2021.

Figure 4. Average BMI among males by age group from January 2017 - October 2021.

Discussion

This study aimed to determine and analyze the weight trajectory of adults in Nebraska over the past five years and determine if the trends vary among age and gender and if the COVID-19 pandemic impacted weight trajectory. Further, this study aimed to compare the collected data to the national obesity prevalence and other researchers' obesity prevalence projections at the national and state level. Within the Nebraska adult population, the average BMI was 30.6, which is classified as obese (BMI ≥ 30). Overall, 47.6% of our study sample was obese (BMI ≥ 30) and 24.0% were severely obese (BMI ≥ 35). The prevalence of obesity among our sample (47.6%) was significantly higher than the Nebraska self-reported obesity prevalence of 34.0% in 2020 (*New Adult Obesity Maps*, 2021).

The results of this study revealed that the prevalence of overall obesity and severe obesity was greater among females (47.9% and 26.8%, respectively) than males (47.1% and 19.9%, respectively), which is consistent with previous studies that have found a higher prevalence of obesity among females than males (CDC, 2017; Wang et al., 2020; Hales et al., 2018; & Hales et al., 2020). From January 2017 to October 2021, the average BMI for both females and males increased among individuals aged 20-49 years, while it decreased among individuals aged 50 years and older. These results differ from a previous study, which found that adults aged 40-59 had the highest prevalence of obesity and severe obesity (Hales et al., 2020). This age group dichotomy among adults aged 40 to 49 years and 50 to 59 years highlights an important area of focus for future studies. This study also revealed that the average BMI for females increased higher among females than for males aged 20-49 years.

Among both females and males, those aged 20 to 29 saw the largest percentage increase in BMI (1.24% and 0.68%, respectively), which is not typically noted by other obesity trend

16

studies (Hales et al., 2018 & Hales et al., 2020). This age group is younger and normally more active, and these larger percentage increases in BMI may be due to changes in lifestyles due to COVID-19 impacts (Lin et al., 2021 & Aghili et al., 2021). Though, when looking at the COVID-19 pandemic that overlapped with the study timeframe (March 2020 to October 2021), no significant change was noted in the average BMI and weight trends among each age group during the COVID-19 pandemic timeframe for both females and males. The lack of anticipated impact on weight gain may be related to Nebraska not having issued "stay-at-home" orders and only providing quarantine and social distancing recommendations. Further, the current study did not follow weight trends beyond October 2021, and the impacts of the COVID-19 pandemic are still ongoing currently (May 2022). Future studies will be needed to identify better and analyze the effects of COVID-19 on weight trajectory.

Table 4 summarizes our study findings compared to the 2030 projections of Ward et al. (2019). As noted in the table, the prevalence of obesity in Nebraska continues to increase toward both the Nebraska projections and the United States overall projections. Though Nebraska has not yet surpassed these 2030 projections, Nebraska adults are incredibly close to their projections, especially for the prevalence of severe obesity. Based on the current study results, it would not be surprising if the overall obesity and severe obesity prevalence among Nebraska adults exceed the Ward et al. (2019) 2030 projections by or before 2030.

Table 4. Prevalence of Adult Obesity and Severe Obesity in October 2021, compared to Ward et al., 2019 2030 projections

		Our Study	Ward et al., 2019 2030 projections, Nebraska[*]	Ward et al., 2019 2030 projections, U.S. Overall[*]
		Percentage (95% CI)		
Overall Obesity (BMI, ≥ 30)	Overall	47.6 (46.8-48.3)	51.3 (49.3-53.3)	48.9 (47.7-50.1)
	Female	47.9 (46.9-48.9)	51.7 (49.2-54.1)	49.9 (48.5-51.4)
	Male	47.1 (45.9-48.3)	51.0 (48.3-53.7)	48.2 (46.8-49.6)
Severe Obesity (BMI, ≥ 35)	Overall	24.0 (23.4-24.7)	25.4 (23.4-27.4)	24.2 (22.9-25.5)
	Female	26.8 (25.9-27.7)	29.6 (27.0-32.2)	27.6 (26.1-29.2)
	Male	19.9 (19.0-20.9)	21.5 (18.9-24.1)	21.1 (19.6-22.6)

Limitations of the present study are necessary to consider when interpreting the results. Several influences may help to explain the differences noted in adult obesity prevalence, causing the variances mentioned in age and gender for this study. Among the possible influences not identified in the current study are the impacts of medication use, weight gain, mid-life crisis weight gain, and lifestyle behaviors varying among age groups and gender, which would benefit from future studies further analyzing the impacts. Although the data for this study was extracted from the patient's EHR, we cannot ensure that all the weight and height data were objectively measured, and the heights and weights were not measured using standardized techniques and/or equipment. If medical providers had asked patients for self-reported weight and height measurements, the data might be subject to bias.

Another limitation of this study is that the encounter number varied by patient and obese individuals are likely to have more medical encounters, which could have skewed our data set.

Further, the study only included individuals with in-person appointments, which may have been

impacted by healthy individuals not seeking routine medical visits during the COVID-19

pandemic. Another limitation of the current study is that we compared our Urban data to Ward et

al. (2019) statewide projections. When comparing our results of the obesity prevalence in

Nebraska to that of the obesity prevalence on a national level, we need to consider further the

regional disparities of obesity prevalence in the U.S., in which obesity prevalence is highest in

the South (32.0%) and the Midwest (31.4%) (Myers et al., 2014 & Wang et al., 2019), which

would also benefit from future studies.

Despite these limitations, this study provides essential information on the current

prevalence of obesity in Nebraska and insight into variances in obesity prevalence by age and

gender. This analysis utilized a large sample (n=16,507) of subjects, with 20% of the sample

being of minority ethnicity. Both further support the generalizability of our findings to the

Nebraska adult population. The EHR data extracted for this study presents a significant

opportunity for future research. This data set can be further utilized to analyze obesity prevalence

by race and ethnicity, as this was not analyzed for the current study. This study also provides

insight and direction for future public health interventions or policy change at the local and state

level. The data utilized in this study will allow for future public health research, and the results

may allow for in-practice identification and implementation of strategies, programs, and

interventions to mitigate and minimize weight gain among adults in Nebraska. Specifically, this

study identifies which age groups and gender should be targeted for such programs and

interventions to reduce Nebraska's weight gain and obesity rates effectively. Further, the current

study results can inform current practices among primary care providers, educators, and

stakeholders interested in reducing obesity and the increased health risks associated with obesity in Nebraska.

Conclusion

Overall, the obesity prevalence in Nebraska continues to move further away from the Healthy People 2030 goal of 36.0% (*Overweight and Obesity- Healthy People 2030,* n.d. This study found that the average BMI has increased among females and males aged 20 to 49, with the highest percentage increase among those aged 20 to 29, and the average BMI decreased among females and males aged 50 and older in Nebraska. Further, we found that the prevalence of obesity is higher among females than males for both overall obesity and severe obesity. We did not observe weight trajectory differences during the COVID-19 pandemic within the study period. Overall, Nebraska is close to reaching and exceeding 2030 obesity prevalence projections, highlighting the importance and critical need for public health interventions to reduce obesity among adults in Nebraska.

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