

## Research

# The relationship between internet and smartphone addiction and body mass index: The mediating role of eating behaviors

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## Abstract

This research was conducted to determine the mediating role of eating habits in the effect of internet and smartphone addiction on body mass index. The study group consisted of 604 individuals aged between 18 and 45 years ( $\text{Mean}_{(\text{Age})} = 21.07$ ,  $\text{SD} = 3.00$ ). Data were collected using Young Internet Addiction Scale, Smartphone Addiction Scale Short Form and Three-Factor Eating Questionnaire. Findings show positive correlations between internet addiction and smartphone addiction with uncontrolled eating, cognitive restraint and emotional eating behavior. Internet and smartphone addiction were determined to positively predict emotional eating behavior, uncontrolled eating behavior and cognitive restraint. The direct effect and total effect of internet addiction on body mass index were insignificant. However, results show that both smartphone and internet use by individuals affect body mass index mediated by eating behavior. This is the first study showing that smartphone and internet use both affected body mass index mediated by eating behavior. Research results emphasize the threat of addiction on physical health and suggest that educational and cognitive dietary interventions can contribute to healthy eating habits. Additionally, considering the internet may be used as an emotion regulation strategy, intervention programs may focus on developing emotion regulation skills aiming to develop coping ability for negative emotions to reduce emotional or uncontrolled eating.

## Public Significance Statement

Lifestyle habits and dietary behaviors begin in early childhood and become fully established during adolescence and young adulthood. The eating habits of individuals aged 18 to 45 should be considered a critical issue, as they can lead to significant lifestyle changes. During this period, individuals take full responsibility for their dietary choices, and their eating behaviors become reinforced in accordance with their professional and social lives. This process may increase their vulnerability in terms of nutrition. Given that eating habits developed and reinforced during this stage often persist into later adulthood, it is crucial to evaluate the predictors and risk factors of eating disorders in young and middle adulthood from both physical and mental health perspectives.

**Keywords** Internet addiction · Smartphone addiction · Eating behavior · Mediation · Body mass index

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## 1 Introduction

Currently, information and communication technologies are an inseparable part of our lives. Many people, particularly young people, spend the majority of their time using technological tools [1]. Smartphones, especially, are very popular in daily life. Smartphones have many diverse functions, and are assessed as irreplaceable technological devices due to instant internet access for people who overuse the internet [2]. Along with the primary feature of the use of internet-based applications, the mobility of smartphones and the ability to upload applications suitable to the individual's needs and lifestyle have made them one of the most multifunctional and multipurpose objects carried at all times by many people [3]. In addition to users talking on the telephone, they may use smartphones to play games, search for information, chat with friends, use messaging systems, and access web services like blogs and social networks. Additionally, the development and global popularity of multifunctional smartphones in recent times has begun to reshape the areas of interest, values and desires of many users and triggered concerns about overuse and addiction [4].

Smartphones have gained more than 1.08 billion users in the world in general since 2012 and this number is reported to rapidly increase [5]. As in the world, the use of smartphones is continuously increasing in Türkiye [6]. The Information Technology Use Research [6] completed in Türkiye identified internet use rates as 55.9%, with 96.8% of households having mobile telephone or smartphone. Considering these rates, it may be said that individuals are at risk of smartphone and internet addiction.

Due to the popularity of smartphones and the increased rates of use, many studies have been conducted on these subjects. Recent studies in the literature have confirmed that smartphone and internet addiction may be associated with mental health [7, 8]. The effects of smartphone and internet use on sleep health are well-documented [9]. Moreover, previous studies have provided evidence for the relationship between internet addiction, irregular meal consumption, eating disorders, and BMI [10–13]. For example, Mokhtar and McGee [14] conducted a systematic review and found that children and adolescents with internet addiction exhibited higher rates of poor dietary habits, irregular eating patterns, and weight control behaviors. Azizi et al. [15] demonstrated that individuals with internet addiction are more prone to being overweight or obese and that internet addiction significantly predicts higher BMI levels. Sanlier et al. [16] identified a relationship between smartphone and internet addiction and abnormal eating attitudes. Similarly, numerous studies have confirmed that internet addiction significantly predicts obesity [17]. However, when the studies are examined, it is possible to say that the mechanisms underlying these relationships are not fully understood.

In recent years, many studies have emphasized that individuals face various health problems due to their eating habits, with significant increases in obesity and diabetes rates [18–20]. Eating habits are among the most important determinants of physical health [21], and it is essential to investigate factors related to individuals' eating habits. Additionally, understanding the impact of smartphone and internet addiction on the fundamental mechanisms affecting physical health may help identify potential targets for clinical interventions. Based on this point, this research aims to determine the mediating role of eating behaviors in the effect of internet and smartphone addiction on BMI. While existing studies generally focus on the direct relationship between internet addiction and BMI, this research seeks to provide a more comprehensive model by highlighting the critical role of eating behaviors in this relationship. These findings will represent an important step in understanding the relationship between digital addiction and obesity and developing effective intervention strategies in this field. Within the context of this study, the following hypotheses were tested:

1. Uncontrolled eating mediates the effect of adults' internet addiction on BMI (Fig. 1a).
2. Cognitive restraint mediates the effect of adults' internet addiction on BMI (Fig. 1b).
3. Emotional eating mediates the effect of adults' internet addiction on BMI (Fig. 1c).
4. Uncontrolled eating mediates the effect of smartphone addiction on BMI among adults (Fig. 1d).
5. Cognitive restraint mediates the effect of smartphone addiction on BMI among adults (Fig. 1e).
6. Emotional eating mediates the effect of smartphone addiction on BMI among adults (Fig. 1f).

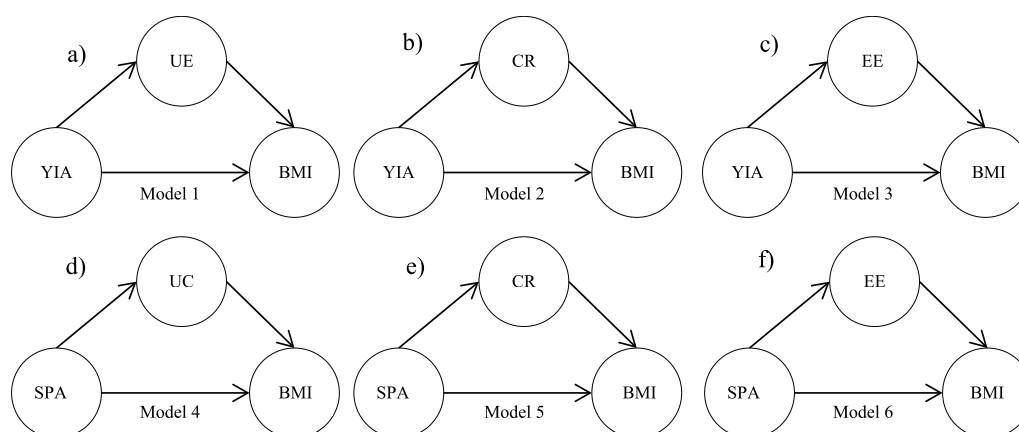


**Fig. 1** Hypothetical Mediation Models. YIA Young internet addiction, SPA Smartphone addiction: UE uncontrolled eating, CR cognitive restraint, EE emotional eating, BMI body mass index

## 2 Participants and methods

### 2.1 Participants

Before beginning the research, legal permission was obtained from Gümüşhane University Scientific Research and Publication Ethics Committee dated 22.06.2022 and numbered 2022/4. The data for this study was collected online via Google Form from adult individuals living in a province in northeastern Turkey between February and May 2022. The study group was determined using the convenience sampling method, selecting participants from units that were easily accessible in terms of cost and labor and where the application could be conducted. Convenience sampling is a commonly used sampling method in research processes due to its practicality and accessibility [22–24]. This method provides researchers with the opportunity to quickly collect data, particularly in situations where reaching the entire population is challenging. Additionally, it also has the potential to reflect general trends. The inclusion criteria for participants in this study were individuals aged 18–45, from various income levels, who use smartphones regularly on a daily basis, have internet access, and do not have any serious psychiatric disorders. The mean age of the study group in the research was 21.07 years ( $Sd$  3.00), comprising a total of 604 people including 501 women (82.9%) and 103 men (17.1%). The sample size of the study was examined by a priori power analysis through G\*Power programme. Accordingly, the minimum sample size was found to be 92 people for  $\alpha=0.05$ , Power  $(1 - \beta)=0.80$ , Effect size  $f^2=0.15$  and 138 for  $\alpha=0.05$ , Power  $(1 - \beta)=0.95$ , Effect size  $f^2=0.15$ . Furthermore it is reported that 460 data are sufficient for multivariate SEM and regression analyses [25]. Therefore, it can be said that conducting analyses with 604 participants for the current study meets the recommended sample size criteria. Descriptive findings about the participants are presented in Table 1.

### 2.2 Measures

#### 2.2.1 Personal information form

A form questioning age, sex, income level, main and snacks per day, daily duration of internet and smartphone use, weight, height and BMI. BMI, calculated as weight in kilograms divided by the square of height in meters BMI was categorized based on the World Health Organization's [WHO] [26] cut-offs: underweight ( $< 18.5 \text{ kg/m}^2$ ), healthy weight ( $18.5\text{--}24.99 \text{ kg/m}^2$ ), overweight ( $25\text{--}29.99 \text{ kg/m}^2$ ), or obese ( $\geq 30 \text{ kg/m}^2$ ).

#### 2.2.2 Young internet addiction test

Developed by Young [27] and adapted to a short form by Pawlikowski et al. [28], the scale comprises 12 items with a 5-point Likert rating (1 = Never, 5 = Very often). There are no reverse items in the scale. High scores on the scale indicate a high level of internet addiction. Confirmatory factor analysis results determined the short form had good fit. The internal consistency coefficient for the scale was calculated as 0.85. The increase in points obtained from the scale indicates high levels of internet

**Table 1** Some characteristics features of participants

|                                          | Male<br>N = 103 (17.1%)<br>N (%) | Female<br>N = 501 (82.9%)<br>N (%) | All<br>N = 604 (100%)<br>N (%) | p        |
|------------------------------------------|----------------------------------|------------------------------------|--------------------------------|----------|
| Age (year) (Mean $\pm$ SD)               | 21.62 $\pm$ 4.38                 | 20.96 $\pm$ 2.63                   | 21.07 $\pm$ 3.00               | 0.227    |
| Body mass index                          | 23.56 $\pm$ 4.29                 | 21.68 $\pm$ 3.32                   | 22.00 $\pm$ 3.57               | < 0.000* |
| Underweight                              | 3 (0.5)                          | 64 (10.6)                          | 67 (11.1)                      |          |
| Normal                                   | 73 (12.1)                        | 367 (60.8)                         | 440 (72.8)                     |          |
| Overweight                               | 20 (3.3)                         | 61 (10.1)                          | 81 (13.4)                      |          |
| Obese                                    | 7 (1.2)                          | 9 (1.5)                            | 16 (2.6)                       |          |
| Income level                             |                                  |                                    |                                |          |
| Low income                               | 48 (7.9)                         | 203 (33.6)                         | 251 (41.6)                     | 0.412    |
| Middle income                            | 44 (7.3)                         | 250 (41.4)                         | 294 (48.7)                     |          |
| High income                              | 11 (1.8)                         | 48 (7.9)                           | 59 (9.8)                       |          |
| Main meals per day                       |                                  |                                    |                                |          |
| 1                                        | 6 (1.0)                          | 10 (1.7)                           | 16 (2.6)                       | 0.000*   |
| 2                                        | 45 (7.5)                         | 328 (54.3)                         | 373 (61.8)                     |          |
| 3                                        | 52 (8.6)                         | 163 (27.0)                         | 215 (35.6)                     |          |
| Snacks per day                           |                                  |                                    |                                |          |
| None                                     | 33 (5.5)                         | 86 (14.2)                          | 119 (19.7)                     | 0.005*   |
| 1                                        | 40 (6.6)                         | 214 (35.4)                         | 254 (42.1)                     |          |
| 2                                        | 24 (4.0)                         | 148 (24.5)                         | 172 (28.5)                     |          |
| 3                                        | 6 (1.0)                          | 53 (8.8)                           | 59 (9.8)                       |          |
| Skipping meal                            |                                  |                                    |                                |          |
| Yes                                      | 46 (7.6)                         | 251 (41.6)                         | 297 (49.2)                     | 0.517    |
| Sometimes                                | 45 (7.5)                         | 189 (31.3)                         | 234 (38.7)                     |          |
| No                                       | 12 (2.0)                         | 61 (10.1)                          | 73 (12.1)                      |          |
| Outside eating                           |                                  |                                    |                                |          |
| Yes                                      | 48 (7.9)                         | 179 (29.6)                         | 227 (37.6)                     | 0.002*   |
| Sometimes                                | 35 (5.8)                         | 262 (43.4)                         | 297 (49.2)                     |          |
| No                                       | 20 (3.3)                         | 60 (9.9)                           | 80 (13.2)                      |          |
| Thinks about healthy eating              |                                  |                                    |                                |          |
| Yes                                      | 14 (2.3)                         | 57 (9.4)                           | 71 (11.8)                      | 0.740    |
| Partly                                   | 54 (8.9)                         | 258 (42.7)                         | 312 (51.7)                     |          |
| No                                       | 35 (5.8)                         | 186 (30.8)                         | 221 (36.6)                     |          |
| Daily duration of internet use           |                                  |                                    |                                |          |
| 1–2 h                                    | 13 (2.2)                         | 39 (6.5)                           | 52 (8.6)                       | 0.288    |
| 3–4 h                                    | 50 (8.3)                         | 258 (42.7)                         | 308 (51.0)                     |          |
| 5–6 h                                    | 29 (4.8)                         | 164 (27.2)                         | 193 (32.0)                     |          |
| 7 h or more                              | 11 (1.8)                         | 40 (6.6)                           | 51 (8.4)                       |          |
| Daily duration of smartphone use         |                                  |                                    |                                |          |
| 1–2 h                                    | 12 (2.0)                         | 35 (5.8)                           | 47 (7.8)                       | 0.357    |
| 3–4 h                                    | 47 (7.8)                         | 221 (36.6)                         | 268 (44.4)                     |          |
| 5–6 h                                    | 31 (5.1)                         | 179 (29.6)                         | 210 (34.8)                     |          |
| 7 h or more                              | 13 (2.2)                         | 66 (10.9)                          | 79 (13.1)                      |          |
| Thinks they are addicted to the internet |                                  |                                    |                                |          |
| Yes                                      | 33 (5.5)                         | 126 (20.9)                         | 159 (26.3)                     | 0.068    |
| Partly                                   | 51 (8.4)                         | 229 (37.9)                         | 280 (46.4)                     |          |
| No                                       | 19 (3.1)                         | 146 (24.2)                         | 165 (27.3)                     |          |
| Thinks they are addicted to smartphone   |                                  |                                    |                                |          |
| Yes                                      | 37 (6.1)                         | 147 (24.3)                         | 184 (30.5)                     | 0.332    |
| Partly                                   | 44 (7.3)                         | 220 (36.4)                         | 264 (43.7)                     |          |
| No                                       | 22 (3.6)                         | 134 (22.2)                         | 156 (25.8)                     |          |

**Table 1** (continued)

\* $p < 0.05$ , independent sample  $t$  test and Pearson Chi-square test were used for numerical data and categorical data, respectively

addiction. Validity-reliability studies completed for Turkish form with the sample of university students determined the Cronbach alpha value for the scale was 0.91 [29]. For this study, the Cronbach alpha value was identified as 0.88.

### 2.2.3 Smartphone addiction scale-short form

This scale was developed by Kwon et al. [30] with the aim of measuring the smartphone addiction risk of adolescents and comprises 10 items with a six-point Likert rating. Scale items are scored from 1 (Strongly Disagree) to 6 (Strongly Agree). The cut-off score for women is 33 and the cut-off score for men is 31. However, total score was used in this study. The increase in points obtained from the test indicates that the risk of addiction is increased. Adaptation to Turkish was performed by Noyan et al. [31], and the Cronbach alpha internal consistency coefficient was stated to be 0.87. For this study, the Cronbach alpha value was identified to be 0.91.

### 2.2.4 Three-factor eating questionnaire

The Three-Factor Eating Questionnaire comprises 21 items. The scale measures in three sections of emotional eating, uncontrolled eating and cognitive restraint. Responses are assessed with a 4-point Likert rating. Points received by participants from each of the three sections are calculated with an algorithm developed by Anglé et al. [32]. The emotional eating factor measures the relationship between negative emotions and overeating. Cognitive restraint refers to restricting food intake for weight control purposes. Uncontrolled eating refers to losing control over food when exposed to external stimuli or when feeling hungry. Accordingly participants receive from 0 to 100 points for each section. A high score in any sub-factor indicates a high level of that eating behaviour in the individual. For Turkish sample Karakuş et al. [33] identified the scale had internal consistency of 0.80 for cognitive restraint, 0.87 for emotional eating, and 0.79 for uncontrolled eating subscales. For this study, the internal consistency coefficients were identified as 0.85 for cognitive restraint, 0.91 for emotional eating and 0.88 for uncontrolled eating subscales.

## 2.3 Statistical analysis

Before analysis of data obtained within the scope of the research, some statistical organization was performed. Within this scope, missing value analysis, extreme values analysis and normal distribution analysis were completed [34]. Firstly, responses given to the data collection tools were assessed. Data from 29 people who did not respond to a large portion of the scales, continuously gave the same responses or left responses blank were not included in the analysis. Then extreme values analysis was completed and 8 values were found to include extreme values and were removed from the data set. After removing missing and extreme values from the research findings, data for the remaining 604 people were included. In line with the aims of the research, statistical analysis was completed with SPSS 24.0 program and Model 4 included in the PROCESS macro. In the model, X represents the independent variable (Young internet addiction, smartphone addiction), Y represents the dependent variable (Body Mass Index) and M represents the mediating variable (Cognitive Restraint, Emotional Eating, Uncontrolled Eating). Nonparametric bootstrap method was used to test the mediation hypotheses. In this way, it is possible to produce larger data sets from the existing data set, the sample size of 604 people was reconstructed as 5000 people with a confidence interval of 0.05, and thus it is possible to reach more reliable results with the larger data set. At this stage, direct, indirect and total effect values were calculated. Within the scope of mediation analyses, firstly, the direct effects of young internet addiction and smartphone addiction on body mass index were calculated. When Cognitive Restraint, Emotional Eating, Uncontrolled Eating levels are included in the mediation model, it gives indirect effects on the effect of Internet addiction and smartphone addiction on body mass index. The sum of direct and indirect effects of internet addiction and smartphone addiction on body mass index is expressed as total effect. The significance of the indirect effects obtained was determined by Preacher and Hayes' bootstrap method, which does not include zero confidence interval and reduces Type 2 error [35]. Within the scope of the research, the hypothesized mediation models are presented in Fig. 1.

**Table 2** Mean, standard deviation, kurtosis, skewness and correlation values

| Variable | 1      | 2      | 3      | 4      | 5      | 6 | Min   | Max    | Mean  | SD    | Skewness | Kurtosis |
|----------|--------|--------|--------|--------|--------|---|-------|--------|-------|-------|----------|----------|
| 1 YIA    | 1      |        |        |        |        |   | 12.00 | 51.00  | 27.45 | 8.18  | 0.32     | −0.43    |
| 2 SPA    | 0.63** | 1      |        |        |        |   | 10.00 | 57.00  | 26.29 | 10.02 | 0.54     | −0.14    |
| 3 UE     | 0.45** | 0.40** | 1      |        |        |   | 0.00  | 100.00 | 42.42 | 22.83 | 0.13     | −0.50    |
| 4 CR     | 0.21** | 0.21** | 0.36** | 1      |        |   | 0.00  | 100.00 | 38.12 | 24.16 | 0.10     | −0.72    |
| 5 EE     | 0.40** | 0.30** | 0.72** | 0.40** | 1      |   | 0.00  | 100.00 | 38.20 | 27.89 | 0.29     | −0.82    |
| 6 BMI    | 0.08   | 0.07   | 0.17** | 0.22** | 0.19** | 1 | 8.26  | 44.08  | 22.00 | 3.57  | 1.33     | 4.75     |

\*\* $p < 0.01$ ,  $N = 604$ . YIA young internet addiction, SPA smartphone addiction, UE uncontrolled eating, CR cognitive restraint, EE emotional eating, BMI body mass index

### 3 Results

The ages of the participants in the study ranged between 18 and 45 and the average age was 21.07. It was found that 4.5% of men and 11.6% of women were overweight or obese. While 8.6% of the men ate three meals a day, 27% of the women reported that they ate three meals a day. It was determined that the rate of eating two meals a day was higher in both men and women. 7.6% of men and 41.6% of women reported skipping meals. When the rate of eating meals outside the home was analysed, it was found that this rate was higher in women with 29.6%. 30.8% of women and 5.8% of men think that they eat healthy.

In terms of daily internet usage, it was determined that 91.4% of the participants used the internet for at least 3 h a day and 92.3% used smartphones for at least 3 h a day. While 26.3% of the participants completely and 46.4% partially considered their cats as internet addicts, 30.5% completely and 43.7% partially considered themselves as smartphone addicts.

Additionally, the height and weight of individuals in the study group were taken and BMI was calculated. Accordingly, the mean BMI of men ( $X = 23.56$ ,  $sd = 4.29$ ) was identified to be higher by significant levels compared to the mean BMI of women ( $X = 21.68$ ,  $sd = 3.32$ ). Descriptive findings about the study group are presented in Table 1.

According to the chi square test results when Table 1 is examined, the daily number of main meals and snacks consumed and eating outside the home were found to differ by gender. It was found that the other variables do not differ according to gender.

Correlation analysis was carried out with the aim of determining the relationships between internet addiction, smartphone addiction, eating behavior and BMI. The correlations between variables, means, skewness and kurtosis values are summarized in Table 2.

When Table 2 is examined, there were positive significant correlations identified between internet addiction and uncontrolled eating ( $r = 0.45$ ,  $p < 0.01$ ), cognitive restriction ( $r = 0.21$ ,  $p < 0.01$ ) and emotional eating ( $r = 0.40$ ,  $p < 0.01$ ). At the same time, there were positive significant correlations determined between smartphone addiction and uncontrolled eating ( $r = 0.40$ ,  $p < 0.01$ ), cognitive restriction ( $r = 0.21$ ,  $p < 0.01$ ) and emotional eating ( $r = 0.30$ ,  $p < 0.01$ ). Finally, there were no significant correlations found between BMI and internet addiction ( $r = 0.08$ ,  $p > 0.05$ ) and smartphone addiction ( $r = 0.07$ ,  $p > 0.05$ ), while there were positive significant correlations with uncontrolled eating ( $r = 0.17$ ,  $p < 0.01$ ), cognitive restriction ( $r = 0.22$ ,  $p < 0.01$ ) and emotional eating ( $r = 0.19$ ,  $p < 0.01$ ).

### 3.1 Mediation analysis

#### 3.1.1 Model 1 (YIA → UE → BMI)

When the results of mediation analysis for prediction of BMI by internet addiction and uncontrolled eating behavior are examined in Table 3, it is seen that BMI was predicted by uncontrolled eating behavior in a positive way ( $\lambda = 0.17$ ,  $p < 0.001$ ), while internet addiction positively predicted uncontrolled eating in a positive way ( $\lambda = 0.45$ ,  $p < 0.001$ ). The direct effect ( $\lambda = 0.00$ ,  $p > 0.05$ ) and the total effect ( $\lambda = 0.08$ ,  $p > 0.05$ ) of internet addiction on BMI were identified to be insignificant. However, when indirect effects are considered, internet addiction was determined to have significant effect on BMI mediated by uncontrolled eating ( $\beta = 0.03$ , 95% CI [0.01, 0.06]). The fully standardized effect size for the

**Table 3** Mediation summary

|         | a.b  |      |      | 95% CI |        | a      |        | b    |      | c    |      | c'   |      | K <sup>2</sup> | 95% CI |    |
|---------|------|------|------|--------|--------|--------|--------|------|------|------|------|------|------|----------------|--------|----|
|         |      | LL   | UL   |        |        | β      | λ      | β    | λ    | β    | λ    | β    | λ    |                | LL     | UL |
| Model 1 | 0.03 | 0.01 | 0.06 | 1.24** | 0.45** | 0.03** | 0.17** | 0.03 | 0.08 | 0.00 | 0.00 | 0.07 | 0.03 | 0.12           |        |    |
| Model 2 | 0.02 | 0.01 | 0.03 | 0.61** | 0.21** | 0.03** | 0.21** | 0.03 | 0.08 | 0.02 | 0.04 | 0.04 | 0.02 | 0.07           |        |    |
| Model 3 | 0.03 | 0.02 | 0.05 | 1.36** | 0.40** | 0.02** | 0.19** | 0.03 | 0.08 | 0.00 | 0.01 | 0.07 | 0.04 | 0.12           |        |    |
| Model 4 | 0.02 | 0.01 | 0.04 | 0.90** | 0.40** | 0.03** | 0.17** | 0.03 | 0.07 | 0.00 | 0.00 | 0.07 | 0.03 | 0.11           |        |    |
| Model 5 | 0.02 | 0.01 | 0.02 | 0.50** | 0.21** | 0.03** | 0.21** | 0.03 | 0.07 | 0.01 | 0.03 | 0.05 | 0.02 | 0.07           |        |    |
| Model 6 | 0.02 | 0.01 | 0.03 | 0.84** | 0.30** | 0.02** | 0.18** | 0.03 | 0.07 | 0.01 | 0.01 | 0.06 | 0.03 | 0.09           |        |    |

Model 1: (YIA → UE → BMI), Model 2: (YIA → CR → BMI), Model 3: (YIA → EE → BMI), Model 4: (SPA → UE → BMI), Model 5: (SPA → CR → BMI), Model 6: (SPA → EE → BMI), β: unstandardized regression coefficients, λ: Standardized regression coefficients

a.b=estimated indirect effect, bootstrapping (N = 5000)

\*\*p < 0.001

mediation effect can be said to have an effect size close to moderate values ( $K^2 = 0.07$ , 95% CI [0.03, 0.12]). In light of the obtained findings, uncontrolled eating behavior may be said to have a significant mediating role between internet addiction and BMI.

### 3.1.2 Model 2 (YIA → CR → BMI)

When the mediation analysis results about prediction of BMI index by internet addiction and cognitive restriction eating behavior are investigated in Table 3, it is seen that BMI was positively predicted by cognitive restriction eating behavior ( $\lambda = 0.21$ ,  $p < 0.001$ ), and internet addiction positively predicted cognitive restriction eating behavior ( $\lambda = 0.21$ ,  $p < 0.001$ ). The direct effect ( $\lambda = 0.04$ ,  $p > 0.05$ ) and total effect ( $\lambda = 0.08$ ,  $p > 0.05$ ) of internet addiction on BMI were identified to be insignificant. When indirect effects are investigated, the effect of internet addiction mediated by cognitive restriction eating behavior on BMI was identified to be significant ( $\beta = 0.02$ , 95% CI [0.01, 0.03]). According to the fully standardized effect size, the mediating effect appeared to have an effect size between low and moderate values ( $K^2 = 0.04$ , 95% CI [0.03, 0.12]). According to the results obtained, cognitive restriction eating behavior may be said to have mediating role between internet addiction with BMI.

### 3.1.3 Model 3 (YIA → EE → BMI)

When the mediating effect of emotional eating behavior in the effect of internet addiction and BMI is assessed, Model 3 documents that BMI was positively predicted by emotional eating behavior ( $\lambda = 0.19$ ,  $p < 0.001$ ), and internet addiction positively predicted emotional eating behavior ( $\lambda = 0.40$ ,  $p < 0.001$ ). The direct effect ( $\lambda = 0.01$ ,  $p > 0.05$ ) and total effect ( $\lambda = 0.08$ ,  $p > 0.05$ ) of internet addiction on BMI were determined to be insignificant. However, when indirect effects are assessed, internet addiction was identified to have significant effect on BMI mediated by emotional eating behavior ( $\beta = 0.03$ , 95% CI [0.02, 0.05]). The mediating effect was found to have effect size close to moderate values according to fully standardized effect size ( $K^2 = 0.07$ , 95% CI [0.03, 0.12]). From the results of the analyses, it appears that emotional eating behavior has a significant mediating role between internet addiction with BMI.

### 3.1.4 Model 4 (SPA → UE → BMI)

According to the results of mediation analysis about predicting BMI by smartphone addiction and uncontrolled eating behavior, BMI was identified to be predicted by uncontrolled eating behavior in a positive way ( $\lambda = 0.17$ ,  $p < 0.001$ ), while smartphone addiction was identified to predict uncontrolled eating behavior in a positive way ( $\lambda = 0.40$ ,  $p < 0.001$ ). The direct effect ( $\lambda = 0.00$ ,  $p > 0.05$ ) and total effect ( $\lambda = 0.07$ ,  $p > 0.05$ ) of smartphone addiction on BMI were determined to be insignificant. However, when indirect effects are considered, smartphone addiction was determined to have significant

effect on BMI mediated by uncontrolled eating behavior ( $\beta = 0.02$ , 95% CI [0.01, 0.04]). When the fully standardized effect size of the mediating effect is examined, it is seen the effect size was close to moderate values ( $K^2 = 0.07$ , 95% CI [0.03, 0.12]). According to the findings obtained, uncontrolled eating behavior appears to play a mediating role between smartphone addiction with BMI.

### 3.1.5 Model 5 (SPA $\rightarrow$ CR $\rightarrow$ BMI)

Continuing to investigate Table 3, according to the mediation analysis results for prediction of BMI by smartphone addiction and cognitive restriction eating behavior, BMI appeared to positively predict cognitive restriction eating behavior ( $\lambda = 0.21$ ,  $p < 0.001$ ), and smartphone addiction appeared to positively predict cognitive restriction eating behavior ( $\lambda = 0.21$ ,  $p < 0.001$ ). The direct effect ( $\lambda = 0.03$ ,  $p > 0.05$ ) and total effect ( $\lambda = 0.07$ ,  $p > 0.05$ ) of smartphone addiction on BMI were determined to be insignificant. However, when indirect effects are examined, smartphone addiction appeared to have significant effect on BMI mediated by cognitive restriction eating behavior ( $\beta = 0.02$ , 95% CI [0.01, 0.02]). The full standardized effect size of the mediating effect can be said to have effect size from low to moderate values ( $K^2 = 0.05$ , 95% CI [0.03, 0.12]). In conclusion, cognitive restriction eating behavior can be said to have a significant mediating role in the effect of smartphone addiction and BMI.

### 3.1.6 Model 6 (SPA $\rightarrow$ EE $\rightarrow$ BMI)

When the mediating effect of emotional eating behavior in the effect of smartphone addiction and BMI is investigated, in Model 6, BMI was identified to predict emotional eating behavior in a positive way ( $\lambda = 0.18$ ,  $p < 0.001$ ), and smartphone addiction was identified to predict emotional eating behavior in a positive way ( $\lambda = 0.30$ ,  $p < 0.001$ ). The direct effect ( $\lambda = 0.01$ ,  $p > 0.05$ ) and total effect ( $\lambda = 0.07$ ,  $p > 0.05$ ) of smartphone addiction on BMI were identified to be insignificant. When indirect effects are assessed, smartphone addiction was found to have significant effect on BMI mediated by emotional eating behavior ( $\beta = 0.02$ , 95% CI [0.01, 0.03]). Considering the full standardized effect size of the mediation effect, it is seen that the effect size is close to moderate values ( $K^2 = 0.06$ , 95% CI [0.03, 0.12]). In this context, emotional eating behavior may be said to have a significant mediating role between smartphone addiction and BMI.

## 4 Discussion

In this study, the mediating role of eating behavior in the effect of internet and smartphone addiction and BMI was researched. In line with the analysis of data, findings show that there were positive significant correlations between internet addiction and smartphone addiction with uncontrolled eating, cognitive restraint and emotional eating behavior. A variety of studies show that during both meals and snacks, distractions, especially watching TV, cause increases in food intake [36]. This seems to be related to the fact that the amount of food consumed as a result of distraction due to TV is not stored in the memory [37]. In fact, cognitive functions in the brain like memory and attention may be affected by several physiological and environmental stimuli. Manipulation of existing cognition while eating affects food intake and it was proposed that cognitive perception and assessment processes have important effects on appetite [38]. Cognitive tasks, especially like watching TV or playing on the computer, at the same time as eating cause disruption of nutrient coding in memory and were determined to increase food intake [37, 39]. Smartphones, computers and the internet are assessed as being the technologies most commonly used during meals [40]. Though these technical developments provide a variety of benefits like rapid communication, ability to stream content, and the ability to interact, some disadvantages like social isolation, and addiction-like behavior were noted and according to current research findings, it seems to interfere with eating behavior. In fact, in the relevant literature, it was confirmed that dysfunctional eating symptoms had a tendency to display excessive internet addiction [41].

Within the scope of the study, internet and smartphone addiction were determined to positively predict emotional eating behavior. When the literature is examined, studies completed within this scope appear to have consistent results to this study [42]. The emotional eating theory proposes that eating may form a regulation mechanism for negative emotions. Accordingly, overeating or binge eating reduces negative feelings in the short term. Additionally, reduced negative emotions reinforces the use of emotional eating and may cause it to become permanent [43]. Considering the use of the internet may ensure avoidance of reality and get away from stress, internet use may function as a dysfunctional

emotion regulation strategy. Similar to emotional eating, internet or smartphone use may ensure relief from difficult emotions in the short term, and may be considered a compensatory strategy to satisfy psychological demands that are not met in reality.

In the study, internet and smartphone addiction were determined to positively predict uncontrolled eating behavior. When studies in the literature are investigated, there are a variety of studies examining the effect of internet or smartphones on eating disorders [13, 44], however, there appears to be no study determining the effect on uncontrolled eating. High levels of internet use may cause uncontrolled eating of snacks that can be easily and rapidly consumed while on the internet. In fact, Odacı and Çelik [45] stated that people with problematic internet use are continuously busy mentally and are mostly unaware of their behavior. In other words, when people spend time on the internet they consume mostly unhealthy snacks without awareness and may experience problems related to eating. Several studies were also found that high internet use was associated with higher likelihood of being obese [46].

As a result of analyses performed within the scope of the research, internet and smartphone addiction were determined to positively predict cognitive restraint. When the literature related to the subject is examined, there was no study investigated the relationship between cognitive restraint and internet or smartphone use. Cognitive restraint represents the tendency to control food intake to preserve body weight or body shape. Eker [47] stated that people attempt to comply with the thin body image presented as being better by modern societies and this affects body perceptions and changes eating habits. In other words, individuals may eat unhealthily and in smaller amounts with the aim of changing the appearance of their body. Especially young people searching for their identity appear to have higher probability of disordered eating attitudes with the effect of exposure to social media applications on the internet, a variety of visuals and magazines and their influences. For this reason, in order to reach the body they desire, young people may deteriorate in their eating behaviors and these people may exhibit risky behaviors such as food restrictions, self-induced vomiting, drug use and diet practices. In the literature, it is reported that eating disorders may develop in individuals due to the desire to look beautiful [48]. Additionally, young people are vulnerable to all comments and criticisms related to physical appearance on social media platforms, which may create more stress and disappointment and this may increase this tendency further.

According to analyses performed within the scope of the study, the direct effect and total effect of internet addiction on BMI were insignificant. There is no study in the literature examining these variables together. However, this study determined that internet addiction had significant effect on BMI mediated by eating behavior. In other words, eating behavior may be said to have significant mediating role between internet addiction and BMI. In the literature, laptop computers, tablets and smartphones were emphasized to be the main distracting elements during leisure and meals [40]. Cognitive models of eating behavior propose that satiety is partly cognitively structured and linked to memory [49]. During a meal, addition of distractors like smartphones, internet or TV to the environment had significant effects on formation of eating memory (diet memory), prevented appropriate knowledge of food intake and thus interfered with hunger and satiation signals. Distractors appear to affect total calorie intake and at the same time eating impulses in a multidimensional way. In fact, research stated that distracted eating increased both food intake and amounts of food consumed at later meals [36]. Additionally, the effect of distraction on calorie intake may be related to the way different dietary contexts affect an individual [50]. When an individual is distracted from internal stimuli like hunger and satiation by external factors, the person eats without limitation, and food intake is not coded to impact the desire to eat. For example, weight loss treatments limiting the duration expended playing video games during meals may cause a larger fall in BMI [51].

In addition to the information above, the use of new technologies and distractors during meals may not only cause an increase in calorie intake, but may also contribute to an immobile lifestyle. Individuals with internet addiction may experience impacts on BMI due to irregular eating behavior during internet use and frequent snacking along with immobility [41]. A study identified that smartphone addiction was positively correlated with immobile behavior [52]. The number of individuals reporting increased body weight and more rapid eating after beginning smartphone use is very high [53]. Young adults using smartphones while eating were found to have increased energy (15%) and fat consumption [54]. Accordingly, unhealthy smartphone use distracts individuals with smartphone and internet addiction, prevents awareness of how much they have eaten and affects food consumption. In summary, energy spent on physical activity reduces and body composition changes leading to increased fat proportion in the body and this causes changes in body weight and BMI.

There are some limitations of the research. The sample of this study is limited to people between the ages of 18–45, determined by convenience sampling, and the research data are based on the self-reports of the participants. In terms of the ability to generalize the findings, it may be beneficial to repeat the research with different samples. In addition, the cross-sectional design of this study obstructs definite results. Studies in the future should explore the temporal relationship

between internet and smartphone addiction with certain eating disorders. Due to the multidimensional nature of the urge to eat, future research should continue to examine information about the effect of distractors on food choice, appetite and eating behavior. In terms of intervention, it may be beneficial for experts working in the field to use internet and smartphone application-based intervention methods to encourage a mindful eating style by asking clients with smartphone addiction to photograph their meals and to pay attention to food while eating in order to raise awareness of the present time.

## 5 Conclusion

To the best of our knowledge, this study is the first study showing that smartphone and internet use both affected BMI mediated by eating behavior. Social media may trigger dysfunctional eating behavior. At this point, the inclusion of public health interventions in social media may provide positive results about by describing both healthy body image and appropriate eating behavior. It is thought that the results of the research will contribute to education about healthy eating habits and cognitive diet interventions, with the emphasis that addiction threatens health. The research results will contribute to education about healthy eating habits and cognitive dietary interventions with the emphasis that addiction threatens health. Additionally, considering the internet may be used as an emotion regulation strategy, intervention programs may focus on developing emotion regulation skills aiming to develop coping ability for negative emotions to reduce emotional or uncontrolled eating.

**Author contributions** The authors contributed to this article as follows: KB conducted the statistical analyses and prepared the method section. TT authored the introduction and discussion sections. HÖY and ÇSM contributed to the other sections of the article through content development, literature review, data collection, and evaluation for clarity and accuracy. All authors critically reviewed the final draft of the manuscript and jointly contributed to ensuring its conformity with academic standards.

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**Data availability** The data that support the findings of this study are available from the corresponding author, upon reasonable request.

## Declarations

**Ethical approval** All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants recruited in the study. Ethical approval was given for the study by the Ethics Committee at Gümüşhane University.

**Conflict of interest** The authors declare no competing interests.

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