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Safe bicycle riding scales based on the transtheoretical model for adolescents: Development and validation

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ABSTRACT

Background: Deaths from bicycle transport have increased by 30% in the past 10 years. This should be considered a problem from various aspects for this reason. Safe bicycle riding concerns not just wearing a helmet; it involves a wide range of matters that must be considered.

Methods: The universe of the study, which is of development and validation design, consisted of fifth, sixth, seventh and eighth grade students (N = 503) enrolled in a middle school located in Istanbul during the 2017–2018 academic year. The data were collected with a 25-item questionnaire on sociodemographic features and bicycle riding behavior, and the Transtheoretical Model of scales. The adolescents in the study group were between the ages of 9–14; 49.5% were female, 50.5% were male. Used in testing for validity and reliability were the Content validity index, exploratory factor analysis, confirmatory factor analysis, floor-ceiling effect, Hotelling's T2, Standard Error of Measurement, the paired sample *t*-test, and Pearson's correlation.

Results: The internal consistency reliability coefficients of the scales are α = 0.79 for the Cognitive Change Process Scale, α = 0.82 for the Behavioral Change Process Scale, α = 0.77 for the Pros Scale of Decisional Balance, α = 0.79 for the Cons Scale of Decisional Balance, α = 0.78 for the Self–Efficacy Scale.

It was found that the Cons Scale of Decisional Balance mean score was under average, all other scale mean scores were above the average. Of the adolescents, 24.5% were in the pre-contemplation stage of change regarding safe bicycle riding in the Transtheoretical Model.

Conclusions: Adolescents' safe bicycle riding behaviors can be evaluated by using scales that are valid and reliable. With the interventions to be implemented, changes can be achieved in safe bicycle riding behaviors and these changes can be screened with the Transtheoretical Model scales.

1. Introduction

The young are particularly vulnerable on the world's roads, and road traffic injuries are the leading cause of death for children and young adults aged 5–29. More than half of all road traffic deaths and injuries involve vulnerable road users such as cyclists, pedestrians and motorcyclists and their passengers (World Health Organization, 2020).

According to the data of the United States' National Highway Traffic Safety Administration, 857 deaths occur per year as a result of bicycle-related injuries, and deaths from bicycle transportation have increased 30% in the last 10 years (National Highway Traffic

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Safety Administration, 2018).

In Turkey, bicycle accidents are reported to constitute 4.8% of traffic-related accidents. In 2019, 8201 individuals were injured in bicycle accidents, while 113 lost their lives (Turkish Ministry of Transportation and Infrastructure, 2019). It is reported that 1150 bicycle accidents occurred only in July 2020 (General Directorate of Security, 2020). Bicycle accidents are among the leading five types of traffic accidents resulting in fatalities (Turkish Ministry of Transportation and Infrastructure, 2019), and most of these (88.89%) occur due to driver culpability (Turkish Ministry of Transportation and Infrastructure, 2019). At the same time, due to the lack or deficiency of bicycle paths and the fact that motor vehicles are the focus of transportation networks, with the result that appropriate crossings and a safe bicycle riding infrastructure has not been implemented, bicycle riders in Turkey are at risk of undergoing bicycle accidents (Turkish Directorate of Strategy and Budget Affairs, 2019).

A review of the literature on safe bicycle riding shows that most research has been carried out on the use of helmets (Dennis et al., 2010; Lee et al., 2009; Ross et al., 2014; Thai et al., 2015).

It is observed that adolescents have been trained just on bike ability (Goodman et al., 2015) and it is seen that the measures developed for bicycle riding have been devised in the context of determining motivations for bicycle riding (Ritchie et al., 2010; Skar et al., 2008), reviewing factors that lead individuals to riding a bicycle (Streicher and Saayman, 2010) and wearing a helmet (Hammond, 2017).

However, bicycle riding should be assessed in an integrated manner to achieve safe riding. Safe bicycle riding involves a wide range of matters that must be considered, including purchasing a bicycle that conforms to anthropometric measurements (Bini et al., 2011; Fern, 2001; Kotler et al., 2016; OECD/International Transport Forum, 2013), wearing individual protective and safety equipment (Beckwith et al., 2019; Fern, 2001; Nuñez et al., 2018; Bini et al., 2011 OECD/International Transport Forum, 2013; Okun, 2015; Magnus Strøh Schmidt et al., 2018), making a safety check of the vehicle before getting on the bicycle (Bini et al., 2011; Fern, 2001; Kotler et al., 2016) adhering to traffic regulations (Okun, 2015; Parkin and Howard, 2008), adopting safe driving techniques (Duan et al., 2017; Li et al., 2012) and correct body positioning (Burke, 2002; Hsiao et al., 2015; Kotler et al., 2016; Larsen et al., 2018; Li et al., 2012; Nuñez et al., 2018; Sommer et al., 2010), learning to be in charge of the bicycle (Heesch et al., 2011; Nuñez et al., 2018; Richmond et al., 2014; Yang and Wu, 2017) and even exercising before and after riding (Hughes et al., 2018; OECD/International Transport Forum, 2013; Parkin and Howard, 2008). These findings show us that wearing a helmet is not enough to practice safe bike riding and that safe bike riding should be assessed on an integrative basis.

Scales provide the means to classify, rank, determine amounts and degrees and the rules or restrictions that must be followed in the context of a particular behavior; they also help in determining the quality of results obtained (Erdoğan et al., 2014; Erkuş, 2012). Using scales that assess safe bicycle riding behaviors provide guidance regarding all the dimensions of the desired behavior and how the behavior can be skillfully taught, how unwanted behaviors can be changed and how behavioral outcomes can be evaluated.

There is thus a need for valid and reliable measuring instruments that enable a model-based, integrated assessment of whether or not the desired behaviors required for safe bicycle riding behavior have been acquired.

The Transtheoretical Model (TTM), for instance, was developed by Prochaska and DiClemente in 1982, then used in many programs in the context of changing negative behaviors (J. J. Prochaska et al., 2008a; Prochaska, 2018; Prochaska and Velicer, 1997) regarding smoking cessation (Erol and Erdogan, 2008), health-improvement (Heller et al., 2013; Velicer et al., 2000), weight loss in the overweight (Armstrong et al., 2011) and physical activity (Han et al., 2017). Behavioral change is defined as a construct realized in stages and focuses on helping individuals to willingly change their behaviors and understand the process of change. The Model has three components. 1. The Stages of Change (the time dimension). 2. The Process of Change (the independent variable dimension), 3. Self-efficacy, Decision-making Measures (levels of change) (J. O. Prochaska and Velicer, 1997). **The Stages of Change** indicate the individual's interest and motivation regarding changing their behavior. This consists of 5 stages. 1. Precontemplation (The individual is unaware of the problem behavior), 2. Contemplation (The individual is considering change within the next 6 months), 3. Preparation (The individual is planning to change in the next month), 4. Action (The individual is in the process of changing; already taking steps) and 5. Maintenance (The individual is keeping up with and continuing the change that was made).

1. **The Processes of Change:** The processes of change are divided into the two components of cognitive (including consciousness raising, dramatic relief, environmental re-evaluation, social liberation, and self-re-evaluation) ["I know I have to check the brakes before I ride a bicycle"] and behavioral processes (including counter-conditioning, stimulus control, helping relationships, reinforcement management, and self-liberation) ["I use safety equipment, although it's not legally mandatory"]. Individuals change their behaviors by using processes of change.
2. **Self-efficacy:** Self-efficacy indicates the degree to which an individual believes that they will be able to successfully exhibit a particular behavior. A high level of self-efficacy shows that an individual's capacity to make a change in behavior is high. ["Even if I feel impatient, I believe I will give pedestrians the right of way when I'm cycling"']
3. **Decisional balance:** these are constructs that set forth pro (benefit) and con (barrier) perceptions regarding behavioral change. Pros indicate positive perceptions about changing a behavior. ["Fitting the bike to my body size protects me from accidents and injuries"]; cons indicate negative perceptions ["I like to see people watching me as I do some acrobatic moves"] (J. J. Prochaska, Spring and Nigg, 2008a; J. O. Prochaska and Velicer, 1997; Wayne F. Velicer et al., 2000).

The TTM is a model that can be used successfully in creating, monitoring and maintaining behavioral change. With regard to using TTM in the context of a measure of safe bicycle riding, however, it can be seen that the model has been employed only for using a helmet (Hammond, 2017); no model-based study that treats all the aspects of bicycle riding has been encountered. In this context, the Transtheoretical Model may be taken as a basis for creating a measure to assess safe bicycle riding.

AIM: This research was carried out towards this aim in the effort to develop Safe Bicycle Riding Scales for Adolescents based on the Transtheoretical Model.

2. Methods

2.1. Design

The study was of development and validation design.

2.2. Universe-sample

The universe of the study consisted of fifth, sixth, seventh and eighth grade students (N = 947) enrolled in a middle school located in the district of Maltepe, Istanbul during the spring term of the 2017–2018 academic year. All of the adolescents were invited to participate in the study, and 875 who agreed to participate were administered the questionnaire. A total of 221 adolescents who had not responded to the control question and 151 adolescents who did not know how to ride a bicycle were excluded from the study; the study was ultimately completed with a total of 503 adolescents.

2.3. Participants

The adolescents in the study group were between the ages of 9–14; 49.5% were female, 50.5% were male. Of the adolescents, 14.9% were in the fifth, 20.1% were in the sixth, 37% were in the seventh, and 28% were in the eighth grades. Among the adolescents, 48.3% said they thought their family's level of income was sufficient; 11.5% described it as insufficient and 40.2% said it was average. Of the mothers, 3% were illiterate, 24.3% were elementary school graduates, 28.3% had middle school, 33% had high school, 10.1% had university education and 1.4% had master's/doctorate degrees. Of the fathers, 0.8% were illiterate, 13.7% were elementary school graduates, 22.9% had middle school, 42.9% had high school, 16.3% had university education and 3.4% had master's/doctorate degrees (N = 503). There were 50 bicycles at the middle school where the data were collected. Adolescents who wish to do so are allowed to ride the bicycles in the schoolyard during physical education class or recess.

2.4. Instruments

The data for the research were collected with a closed-ended 25-item questionnaire on *sociodemographic features and bicycle riding behavior and* the *Transtheoretical Model of scales* and *The Stages of Change Questionnaire.*

2.5. Creating the item pool

The Delphi technique was employed in the creation of the scale item pool. A 60-item scale item pool was created in line with the recommendations of professional cyclists and the literature concerning safe bicycle riding (Beckwith et al., 2019; Bini et al., 2011; Bromell and Geddis, 2017; Burke, 2002; Duan et al., 2017; Fern, 2001; Fishman et al., 2013; Hammond, 2017; Heesch et al., 2011; Hsiao et al., 2015; Hughes et al., 2018; Karkhaneh et al., 2011; Kotler et al., 2016; Larsen et al., 2018; Li et al., 2012; Lin et al., 2017; Nuñez et al., 2018; OECD/International Transport Forum, 2013; Okun, 2015; Parkin and Howard, 2008; Richmond et al., 2014; Schmidt et al., 2018; Sommer et al., 2010; Thai et al., 2015; Yang and Wu, 2017).

In the first stage, the 60 items were sent to 11 biking experts (seven nursing academics, two physiotherapists and two licensed professional bikers). The experts had at least eight years of work experience. They were asked to provide responses to the question, "What are safe bicycle riding behaviors?" and expected to respond on the basis of a 7-point Likert scale ranging from "1. Totally inappropriate, should not be included in the scale" to "7. Very appropriate, should definitely be included in the scale." The scale items rose to 90 with the recommendations, and 22 items were removed due to lack of agreement; agreement was achieved in 78 items in three steps.

The items agreed upon were set up according to the TTM. The scales were named the Cognitive Change Process Scale, Behavioral Change Process Scale, Pros Scale of Decisional Balance, Cons Scale of Decisional Balance and the Self-Efficacy Scale.

For testing for content validity, the items were sent to a different group of experts with at least five years of experience who knew how to ride a bicycle. Three of the 11 experts in this group were licensed professional bikers, two were academics in physiotherapy, four were in public health, one was a child and two were psychiatric nursing academics. The experts' opinions were evaluated with the scale-level content validity index, universal agreement calculation method in terms of Polit and Beck's content validity index (Polit and Beck, 2006). Also, age appropriateness and comprehensibility were assessed with the Flesch-Kinkaid program (Ease, 2009). Incomprehensible words were replaced by more appropriate ones. Lastly, a linguist was asked to make an assessment. Draft scales were created. The draft scales were assessed in a pilot study with 87 middle school pupils. It was decided that the data collection instruments were appropriate and that data could be collected in the adolescents' own classrooms in 20–45 min. The implementation was executed with adolescents in a different middle school in their own classrooms and during one class hour.

2.6. Introduction of the transtheoretical model questionnaire and scales

2.6.1. The Stages of Change Questionnaire

Indicates the individual's interest and motivation regarding changing their behavior (J. O. Prochaska et al., 2008b; Prochaska and Velicer, 1997; Velicer et al., 2000). To evaluate the stages of change in this study, a definition of safe bicycle riding drawn up on the basis of the literature was explained to the students, who were asked to make an assessment of their own bicycle riding behaviors. "Safe Bicycle Riding": Riding a bicycle suited for one's body measurements, using safety equipment, adhering to safe driving techniques, obeying traffic regulations, promptly having the bicycle checked for maintenance, exercising before and after riding, riding with a body position that will protect against collision and injury and engaging in body fitness behavior. Do you think you ride your bike in accordance with this definition of safe bicycle riding? Mark the option that best suits you among the five statements. 1. No, and I do NOT intend to do so in the next 6 months [Precontemplation], 2. No, but I intend to do so in the next 6 months [Contemplation], 3. No, but I intend to do so in the next 30 days [Preparation], 4. Yes, I have been riding this way for LESS than 6 months [Action], 5. Yes, I have been riding this way for MORE than 6 months [Maintenance]. The student's stage of change was determined on the basis of the response to this question.

2.6.2. The processes of Change Scales

The processes of change are divided into the two components of cognitive and behavioral processes. Individuals change their behaviors by using processes of change (J. O. Prochaska et al., 2008b; Prochaska and Velicer, 1997; Velicer et al., 2000).

The Cognitive Change Process Scale (CCPS): The higher the scores on the CCPS, the higher is the level of knowledge about safe bike riding. "I know I have to check the brakes before I ride a bicycle."

The Behavioral Change Process Scale (BCPS): Higher scores on the BCPS indicate that adolescents ride their bikes safely. "I use safety equipment, although it's not legally mandatory."

2.6.3. The self-efficacy scale

Self-efficacy indicates the degree to which an individual believes that they will be able to successfully exhibit a particular behavior (J. O. Prochaska et al., 2008b; Prochaska and Velicer, 1997; Velicer et al., 2000).

The Self-Efficacy Scale (SES): It is accepted that the higher the SES scores, the higher is the individual's self-efficacy regarding safe bike riding in negative situations. "Even if I feel impatient, I believe I will give pedestrians the right of way when I'm cycling."

2.6.4. The decisional balance scales

These are constructs that set forth pro and con perceptions regarding behavioral change (J. O. Prochaska et al., 2008b; Prochaska and Velicer, 1997; Velicer et al., 2000).

The Pros Scale of Decisional Balance (PSDB): It is accepted in the PSDB that the higher the score, the higher the perception of pros regarding safe bike riding. "Fitting the bike to my body size protects me from accidents and injuries."

The Cons Scale of Decisional Balance (CSDB): It is accepted that the higher the CSDB scores, the more there are barriers to safe bike riding. "I like to see people watching me as I do some acrobatic moves."

There were no items that required reverse scoring for all scales.

2.7. Data analysis

The data thus obtained were evaluated with the SPSS 22.0 and Amos 16 software. EFA, the Kaiser-Meyen-Olkin (KMO) and Bartlett's tests, as well as CFA were performed for validity. For reliability, Cronbach's Alpha Coefficient, Tukey's test of non-additivity to see whether factors are additively related, and item-total scores and average inter-item correlation coefficients were calculated. The paired samples *t*-test and SEM were employed to assess invariance or consistency over time. Also, Hotelling's T-Squared and floor-ceiling effect analysis were performed.

2.8. Ethical considerations

Prior to the data collection, approval for the study was obtained from first the Istanbul District Directorate of Education and then from the administrations of the schools. An ethics approval was received from the Marmara University Health Sciences Institute Ethics Committee and written consent was obtained from the adolescents and their parents.

3. Results and discussions

The results of the study were presented in the form of validity and reliability testing of the TTM scales regarding safe bicycle riding and in terms of the stages of change.

3.1. Validity results and discussions

Content validity, scale validity and construct validity analyses are carried out in testing validity (Büyüköztürk et al., 2017; Erdoğan et al., 2014; Whitehead, 2013).

3.1.1. Content validity

Polit and Beck's (2006) CVI was used in this context. For the scale and the item's content validity to be at a sufficient level, the value must be 0.80 or more (Polit and Beck, 2006). The CVI values for the CCPS was 0.94, 0.91 for BCPS, 1 for PSDB, 0.88 for CSDB and 0.95 for SES. The CVI's of all the scales and their items were 0.80 and above; therefore, the scales were found to be valid in terms of content validity.

3.1.2. Construct validity

In the analysis of basic components, all of the TTM Safe Bicycle Riding Scales were found to have a factor size in terms of KMO values that was conducive to conducting a factor analysis and the results of Bartlett's test were statistically significant in all of the scales ($p(sig) = 0.000 < 0.05$) (Table 1). Construct validity depends on whether the Kaiser- Meyer-Olkin (KMO) coefficient is over 0.60 and Bartlett's test produces a significant result (Büyüköztürk, 2018). According to the KMO coefficient, the sample size is on a good and very good level (Whitehead, 2013).

According to Bartlett's test, there are high correlations between the variables in the scales, the data are of multivariate normal distribution and sample sizes are adequate (Büyüköztürk, 2018; Whitehead, 2013). Factor analysis is performed as exploratory or as confirmatory factor analysis.

3.1.2.1. Exploratory factor analysis. In exploratory factor analysis, it is recommended that the lower limit of item factor loadings is kept high. Because of this, the lower limit for item factor loadings for the scale was accepted as 0.50 and the overlapping limit was ∓0.20 (Çokluk, Ö., Şekercioğlu, G., & Büyüköztürk, 2012). In factor analysis, it is recommended that 3 or more items are loaded for each factor (Kartal and Bardakçı, 2019).

Each scale (drawn up in accordance with the cognitive process, behavioral process, benefit perception, harm perception and self-efficacy) in safe cycling was analyzed separately for exploratory factor analyses. When rotation factor loads were calculated, it was seen that all of the scales consisted of a single dimension. The results of the Exploratory Factor Analysis performed on the TTM Safe Bicycle Riding Scales are shown in Table 2.

At this point, CCPS was analyzed with 20 items, with the analysis revealing that items 9, 5, 6 had factor loadings that were below 50, and items 8, 13, 15 and 18 were overlapping, and since the number of items in their factor was less than three (17, 14, 16), these items were removed from the scale. Ultimately, CCPS consisted of 10 items.

The Behavioral Change Process Scale was analyzed in the form of 16 items, with the analysis revealing that items 22, 30, 36 had factor loadings of below 0.50 and items 26, 32, 24, and 31 were overlapping. Since the number of items in the factor was less than three (25, 29), these items were removed from the scale. Ultimately, BCPS consisted of 7 items.

In the Pros Scale of Decisional Balance, this was analyzed with 14 items. It was found that factor loadings for items 23, 25 were below 0.50, items 1, 4, 6, were overlapping. Since the number of items in their factor was less than three (8, 11, 14), these items were removed from the scale. It was thus decided that PSDB would consist of 6 items.

CSDB was analyzed with 13 items, after which it was found that items 13, 15, and 21 had factor loadings of below 0.50, items 22, 26 were overlapping. Since the number of items in their factor was less than three (18, 19), these items were removed and CSDB ultimately consisted of 6 items.

The SES was analyzed with 14 items. The results of the analysis showed that items 3,4,7 and on SES had factor loadings of below 0.50 and items 8, 10 and 15 were overlapping. Since the number of items in their factor was less than three (1,2), these items were removed from the scale, leaving the scale with 6 items (Table 2).

Construct of scales: The invariable basic structures in the Transtheoretical model are the question about the stage of change the individual is in, the processes of change (cognitive and behavioral), decision-making (pros/cons) and self-efficacy (Prochaska and Velicer, 1997). Although the main structures of the transtheoretical model do not change, the measure that is used and the number of its subscales can vary. In this study, the safe bicycle riding TTM measures were developed as follows: Two scales, one for the process of change and the other for the cognitive and behavioral changes; two scales for decisional balance and for pros/cons; and a single scale

Table 1
Test results of sample size assessment.

Components of TTM	Scales	N	KMO	Barlett test Scores
Scales that assess TTM Processes of Change	The Cognitive Change Process Scale	503	0.862	971.051
	The Behavioral Change Process Scale	503	0.877	1063.967
Scales that assess TTM Decisional Balance Scales	The Pros Scale of Decisional Balance	503	0.842	626.396
	The Cons Scale of Decisional Balance	503	0.839	768.264
Scales that assess TTM Self-Efficacy assessment scales	The Self-Efficacy Scale	503	0.693	210.713

Note. TTM: Transtheoretical Model, KMO: Kaiser-Meyen-Olkin.

Table 2
Items included in exploratory factor analysis and results.

Scales	Items analyzed	Items re-moved	Items remain-ing	Number of remain-ing items	Factor Number	Total Variance Explained	Factor loading intervals of scale items
CCPS	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,34	17,14,16, 9,					
5,6,8,13,15, 18	1,2,3,4,7,10,11,12,19,34	10 Items	1	%35.337	0.522–0.665		
BCPS	20,21,22,23,24,25,26,27,28,29,30,31,32,35,36,37	22,30,36,26,32,24,25,29,31	20,21,23,27,28, 35,37	7 Items	1	%49.035	0.536–0.815
PSDP	1,2,3,4,5,6,7,8,9,10,11,14,23,25	1,4,6,8,11,14,23,25	2,3,5,7,9,10	6 Items	1	%46.88	0.650–0.724
CSDP	12,13,15,16,17,18,19,20,21,22,24,26,27	13,15,18,19,21,22,26	12,16,17,20, 24,27	6 Items	1	%49.88	0.662–0.736
SES	1,2,3,4,5,6,7,8,9,10,11,12,13,15	1,2,3,4,7,8,10,15	5,6,9,11,12,13	6 Items	1	%48.154	0.606–0.751
Control Questions	BCPS33, SES14	–	–			–	–

Note. CCPS: The Cognitive Change Process Scale, BCPS: The Behavioral Change Process Scale, PSDP: The Pros Scale of Decisional Balance, CSDP: The Cons Scale of Decisional Balance, SES: The Self-Efficacy Scale. Varimax was used as a rotation method in the factors that observed according to exploratory factor analysis.

for self-efficacy. A look into other studies using the TTM indicates that the scale structures developed based on the TTM model for an assessment of exercising behavior in the elderly are the same as what we have used in our research (Cheung et al., 2007). Researchers in a study on using a bicycle helmet have structured the scales on the basis of change processes (experimental and behavioral), decisional balance (pros and cons), and self-efficacy (confidence and temptation) (Hammond, 2017). Scale structures on making a change in sedentary life (Han et al., 2015) and changing exercise behavior (Gümüş and Kitiş, 2015) have been developed to consist of processes of change, decisional balance (pros and cons) and self-efficacy. In a study on Green Eating Behaviors, the authors developed their scales as two separate ones for decisional balance and for pros and cons, and a self-efficacy scale with two subscales for self-efficacy at home and at school (Weller et al., 2014). In another study on changing exercising behavior, cognitive and behavioral processes included the elements of consciousness raising, dramatic relief, environmental re-evaluation, social liberation, and self-re-evaluation, counter-conditioning, stimulus control, helping relationships, reinforcement management, and self-liberation, decisional balance (perceptions of pros and cons) and self-efficacy (Blaney et al., 2012).

3.1.2.2. Confirmatory factor analysis. The results of the exploratory factor analysis were tested for construct validity with confirmatory factor analysis.

When CFA indicates that X2/df < 3, this points to an excellent model fit and 3 < X2/df < 5 is acceptable (Çokluk, Ö., Şekercioğlu, G., & Büyüköztürk, 2012; Erdoğan et al., 2014; Kruger et al., 2010). In the review of the CFA goodness of fit indexes, it is accepted that a value of <0.08 in RMSEA and a value of >0.80 or >0.95 in NFI indicates a good fit. A value of >0.95 in TLI, of 0.90 and, according to some research, of >0.95 in CFI indicates a good fit. Other indications of good fit are an IFI value of 0.90 and over, of over 0.90 in GFI and over 0.90 in AGFI. Although PNFI and PGFI do not have definitive limits, a minimum value of 0.50 and a value of 0.90 in RFI indicate a good fit (Erdoğan et al., 2014; Hooper et al., 2008; Marsh and Hau, 1996). RMR value is sensitive to the scale and is not considered an indication in assessing good fit (Hooper et al., 2008).

The first-level diagram for the CCPS model after the CFA is shown in Fig. 1. The correlation coefficients on the scale varied between 0.47 and 0.63. The values obtained from the goodness of fit indexes are X2/df = 108.218/36 = 3.006, RMSEA = 0.063, NFI = 0.889, TLI = 0.903, CFI = 0.923, IFI = 0.923, GFI = 0.958, AGFI = 0.935, RMR = 0.97 for BCPS scale.

The first-level diagram for the BCPS model after the CFA is shown in Fig. 2. The correlation coefficients on the BCPS scale varied between 0.42 and 0.80. The values obtained from the goodness of fit indexes are X2/df = 34.696/15 = 2.313, RMSEA = 0.051, NFI = 0.968, TLI = 0.974, CFI = 0.981, IFI = 0.981, GFI = 0.980, AGFI = 0.963, RMR = 0,108 for the BCPS scale.

The first-level diagram for the PSDB model after the CFA is shown in Fig. 3. The correlation coefficients on the PSDB scale varied

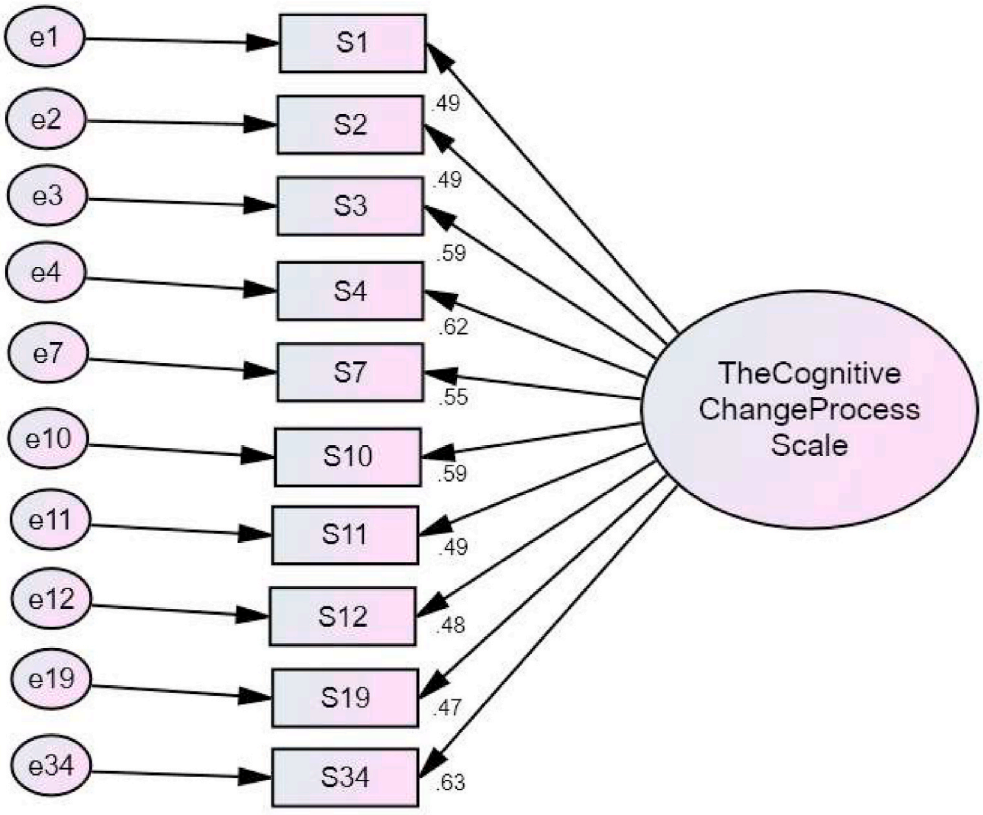

Fig. 1. The first-level CFA diagram of CCPS.

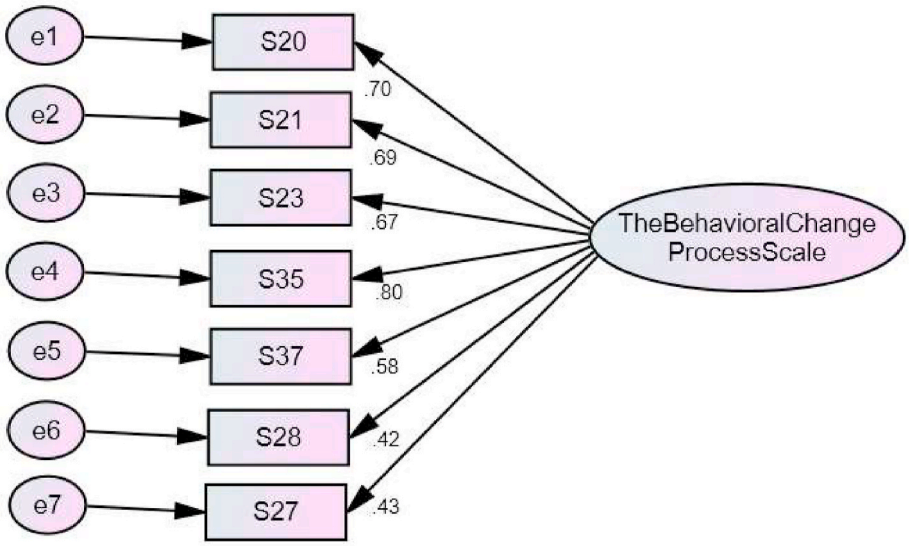

Fig. 2. The first-level CFA diagram of BCPS.

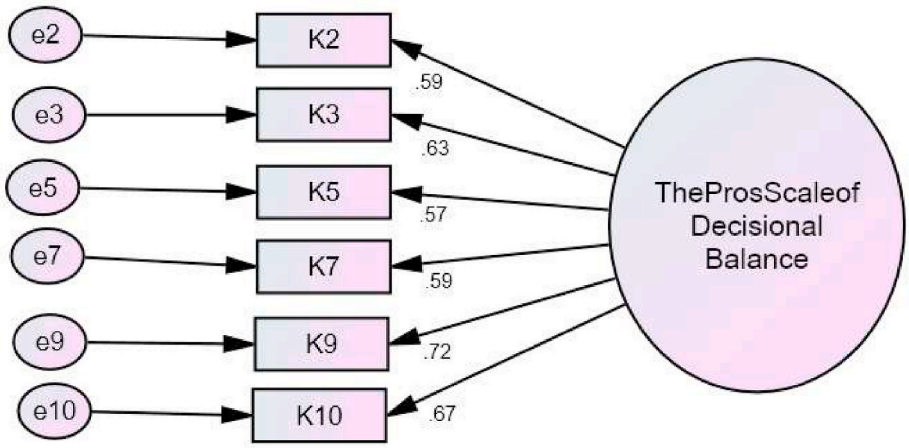

Fig. 3. The first-level CFA diagram of PSDB.

between 0.57 and 0.72. The values obtained from the goodness of fit indexes are X2/df = 23.666/10 = 2.367, RMSEA = 0.052, NFI = 0.962, TLI = 0.967, CFI = 0.978, IFI = 0.978, GFI = 0.984, AGFI = 0.967, RMR = 0.125 for PSDP scale.

The first-level diagram for the CSDB model after the CFA is shown in Fig. 4. The correlation coefficients on the CSDB scale varied between 0.57 and 0.68. The values obtained from the goodness of fit indexes are X2/df = 40.048/10 = 4.005, RMSEA = 0.077, NFI = 0.948, TLI = 0.941, CFI = 0.9606, IFI = 0.961, GFI = 0.974, AGFI = 0.945, RMR = 0,090 for the CSDB scale.

The first-level diagram for the SES model after the CFA is shown in Fig. 5. The correlation coefficients on the SES scale varied between 0.59 and 0.64. The values obtained from the goodness of fit indexes are X2/df = 33.373/9 = 3.708, RMSEA = 0.073, NFI = 0.846, TLI = 0.798, CFI = 0.879, IFI = 0.882, GFI = 0.969, AGFI = 0.927, RMR = 0.096 for the SES scale. Accordingly, it can be accepted that all scales displaying this quality fit the model.

Based on these goodness of fit values, it was decided that the scales were good model fits. The scales were examined in the light of the maximum likelihood technique and it was seen that they maintained single-dimensional constructs.

In another evaluation, values of 0.94 for NNFI, 0.95 for CFI, >0.90 for GFI, AGFI, NNFI and CFI, and <0.08 for RMR have been reported as indications of a good fit (Kruger et al., 2010; Marsh et al., 2006). When compared with these values also, the scales show a good model fit.

The standardized factor loadings (λ) are shown in Figs. 1–5; all λ values were found to be above 0.43. The literature indicates that λ values of over 0.32 are acceptable (Tabachnick and Fidell, 2007). Various studies say that if loadings are $\lambda > 0.40$ these have to be interpreted against the theoretical background. At this point, t values need to be examined to understand to what degree each observed variable is significantly predicted by latent variables. Since the t values of all of the items were found to be significant and around the

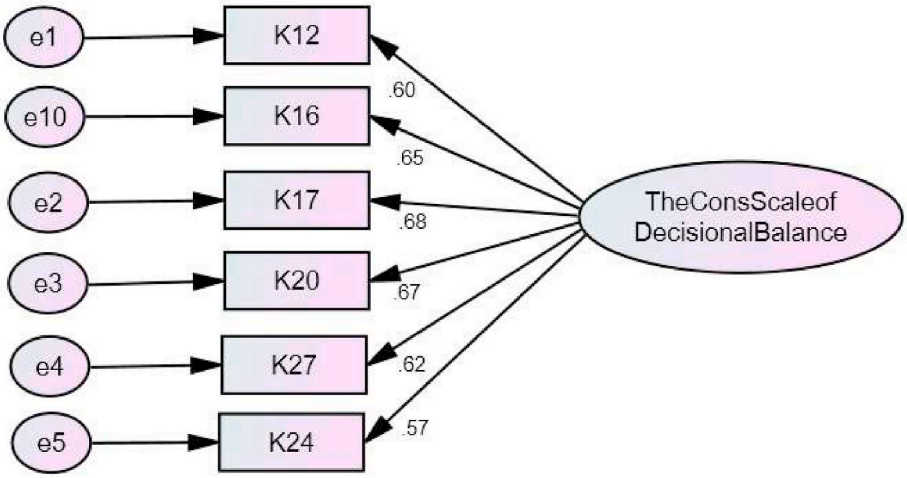

Fig. 4. The first-level CFA diagram of CSDB.

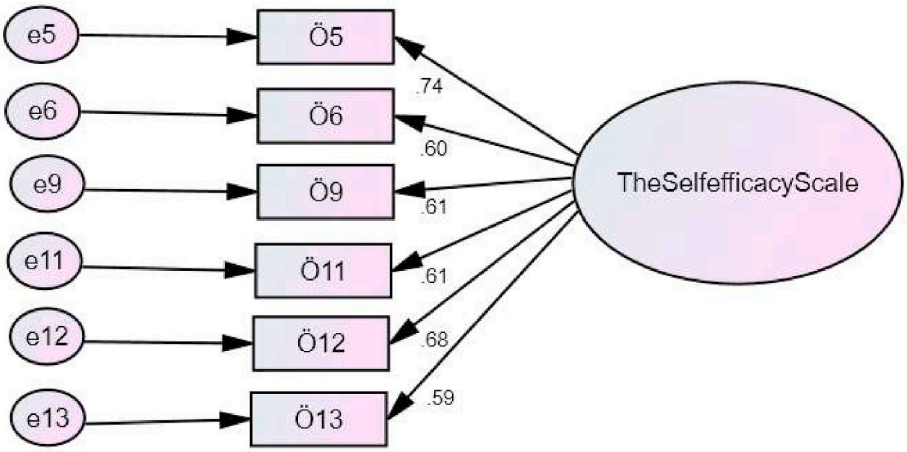

Fig. 5. The first-level CFA diagram of SES.

level of 0.001, there was no incompatibility between the observed and latent variables. All of the items were thus kept in the model (Byrne, 2013; Çokluk, Ö., Şekercioğlu, G., & Büyüköztürk, 2012; Marsh et al., 2010).

3.1.3. Scale validity

This is divided into internal and external validity. There is no other measuring instrument that can be used to assess Safe Bicycle Riding. Because of this, the internal validity of the scale was tested to determine scale validity. To test the internal validity of the scale,

Table 3
Comparison of lower (27%) and upper (27%) groups.

Scales	27% Lower Group (n = 136)		27% Upper Group (n = 136)		Levene's Test for Equality of Variances		*t*-test for Equality of Means[a]		
	$\overline{X}$	ss	$\overline{X}$	ss	F	Sig.	t	p	df
CCPS	25.10	4.31	45.58	2.84	**19.058**	**.000**	**46.22**	**0.00**	**233.58**
BCPS	12.26	2.72	30.61	2.73	.002	.969	55.43	.969	270
PSDB	15.63	2.99	28.66	1.29	**42.906**	**.000**	**46.55**	**.000**	**183.616**
CSDB	7.41	1.48	23.52	3.49	**91.014**	**.000**	**−49.44**	**.000**	**182.365**
SES	15.24	3.60	29.16	.97	**138.918**	**.000**	**43.49**	**.000**	**154.77**

[a] Independent groups *t*-test.

a comparison was made of the 27% Lower and 27% Upper groups and the scale's discrimination, item-total correlations and item discrimination were studied.

Comparison of Lower (27%) and Upper (27%) Groups: When there is a significant difference between the item mean scores of the Lower 27% and Upper 27% groups, it is expected that the scales should be able to discriminate between the two opposing groups

Table 4
Items of processes of change scales that assess the transtheoretical model.

The Cognitive Change Process Scale			$\bar{x}$	sd	r_{jx}	r		α^1	α^2
Self-re-evaluation	S1	I think wearing a helmet will reduce the risk of head injury	4.23	1.16	.467	.423		.693	.781
Consciousness raising	S2	I know I have to check the brakes before I ride a bicycle	4.08	1.24	.490	.427		.691	.780
Self-re-evaluation	S3	I think that having my bike serviced will protect me from injuries.	3.90	1.26	.579	.510		.687	.771
Self-re-evaluation	S4	I believe that exercising before and after cycling will prevent injuries	2.67	1.46	.604	.539		.777	.767
Consciousness raising	S5	Holding the handgrip/handlebar prevents the hands from sweating and sliding	3.73	1.36	.327	.199		.699	
Consciousness raising	S6	I know how to use protective equipment appropriately	3.62	1.42	.456	.288		.688	
Consciousness raising	S7	I know I need to increase my visibility with reflectors when I ride a bicycle	3.35	1.46	.550	.486		.684	.773
Dramatic relief	S8	I get anxious when my friends do acrobatic stunts on the bicycle (like riding on a single wheel)	3.60	1.52	.394	.256		.693	
Dramatic relief	S9	I am sad to hear about someone being disabled because of an accident where he/she did not wear a helmet	4.34	1.09	.389	231		.699	
Environmental re-evaluation	S10	If I use protective equipment such as knee pads when I'm cycling, I can be a good example to others.	3.84	1.37	.583	.514		.682	.770
Social liberation	S11	I observe that cyclists wear gloves	2.91	1.51	.495	.424		.697	.781
Dramatic relief	S12	I think of people who would be affected if I had injured because I was on my cellphone while riding a bike	3.91	1.38	.490	.417		.691	.782
Social Liberation	S13	I notice that the bicycle paths in my neighborhood have increased	2.85	1.46	.286	.226		.700	
Self-re-evaluation	S14	I believe that I would have more friends if I didn't use personal protective equipment	3.89	1.47	.118	.354		.736	
Environmental re-evaluation	S15	I believe that I can harm the environment if I don't obey traffic regulations when cycling	4.00	1.29	.400	.235		.695	
Self-re-evaluation	S16	I think If I wear wrist protector, my friends will make fun of me.	3.93	1.46	. 316	.113		.792	
Self-re-evaluation	S17	I believe I will be more popular among my friends if I wear a helmet	4.02	1.41	.197	.426		.741	
Consciousness raising	S18	I know that I have to signal right or left when I'm turning in traffic	3.64	1.47	.528	.348		.681	
Consciousness raising	S19	I know there are rules I can follow for falling off a bike safely	3.57	1.46	.508	.403		.689	.784
Dramatic relief	S34	I'm proud of myself when I use safety equipment when I'm riding a bicycle	3.15	1.52	.561	.520		.684	.769
The Behavioral Change Process Scale			**$\bar{x}$**	**sd**	**r_{jx}**	**r**	**α^1**	**α^1**	**α^2**
Stimulus control	S20	I keep the individual protective equipment (helmets, goggles, gloves, etc.) that I will wear when cycling, within easy reach	3.11	1.52	.737	.615		.831	.791
Stimulus control	S21	I avoid cycling without a helmet	2.70	1.51	.761	.648		.829	.786
Helping relationships	S22	I share my negative experiences with riding a bike with someone	3.16	1.45	.336	.128		.846	
Helping relationships	S23	I choose my biker friends from those who wear individual protective equipment	2.55	1.50	.741	.623		.832	.790
Helping relationships	S24	My family supports me in using safety equipment (e.g., helmet, goggles, gloves, mirror, reflector, bell/horn) when I'm riding a bike	3.52	1.47	.492	.282		.837	
Counter-conditioning	S25	I prefer to wear a helmet rather than a hat when I'm cycling	3.02	1.62	.614	.502		.829	
Counter-conditioning	S26	I ride a bicycle wearing closed shoes instead of slippers/sandals	4.29	1.09	.317	.182		.846	
Counter-conditioning	S27	I prefer to wear iridescent or light-colored outfits rather than dark colors when I'm riding a bike	3.18	1.40	.682	.428		.848	.823
Counter-conditioning	S28	I ride a bicycle with clothes that fit tightly rather than loosely	3.33	1.37	.797	.414		.849	.823
Stimulus control	S29	When I'm thirsty, I stop my bicycle to drink some water	4.25	1.16	.340	.270		.846	
Self-liberation	S30	On a multi-lane road, I ride my bike in the middle of the right lane	3.40	1.41	.386	.189		.843	
Counter-conditioning	S31	I cycle in the direction of traffic rather than in the opposite direction	3.85	1.30	.246	.120		.849	
Counter-conditioning	S32	If traffic is busy at a crossroad, I cross over with the pedestrians instead of with the vehicles	3.67	1.36	.403	.211		.842	
Reinforcement management	S35	I use safety equipment, although it is not legally mandatory	3.00	1.53	.579	.696		.827	.777
Reinforcement management	S36	I could warn others if my bike had a bell/horn	4.18	1.16	.367	.218		.844	
Self-liberation	S37	I protect my head with my helmet by tilting my head forward in case of a fall	3.53	1.57	.564	.537		.832	.805

Note. $\bar{x}$ = Items mean, sd = standard deviation, rjx = Items-total score correlations, r = corrected item-total correlation, α1 = Cronbach's alpha if item deleted (**when gray items were removed) α^2**= Cronbach's alpha if item deleted.

(Erkuş, 2012; Tezbaşaran, 2008). Table 3 displays the mean differences between the 27% (n = 136) group with the lowest scores in the distribution of total scores and the 27% group with the highest scores (n = 136).

It was found that the upper groups had significantly higher mean scores than the lower groups on the CCPS, PSDB, CSDB and SES. It was seen that these scales were able to differentiate the 27% lower group from the 27% upper group.

In this context, it was seen that the CCPS, PSDB, CSDB, SES were scales that could discriminate between two opposing groups. In the other scales, the analysis showed that the two groups could not be distinguished from each other.

Item-Total Correlations (item discrimination index values) can be examined for internal scale validity (Erkuş, 2012). Item-total correlations indicate the relationship between the question score and the overall assessment score (Whitehead, 2013). The desired item-total correlation coefficient is at least 0.20 or 0.25 (Büyüköztürk, 2018; Tavşancıl, 2019) has reported that item-total correlations of 0.30 and over indicate that the items discriminate between individuals.

When Item discrimination index values were considered, it was seen that these values were 0.467–0.583 for CCPS, 0.564-0.761 for

Table 5
Items of decisional balance and self-efficacy scales that assess transtheoretical model.

	The Pros Scale of Decisional Balance	$\bar{x}$	sd	r_{jx}	r	α^1	α^2
K1	Smart cyclers use security equipment such as a helmet, gloves, front and rear lights	3.89	1.28	.505	.303	.768	
K2	If I distribute my body weight equally to the handlebar, seat and pedal, I get less tired when cycling	3.64	1.29	.669	.496	.768	.743
K3	Fitting the bike to my body size protects me from collisions and injuries	4.05	1.18	.684	.533	.763	.735
K4	Checking the brakes before starting off prevents accidents and injury	4.28	1.04	.492	.318	.772	
K5	If my fingertips touch the ground when I'm sitting on the saddle, I can stand up easier in unexpected situations	3.84	1.29	.658	.483	.768	.747
K6	It's cool to have a flashing red light in the back	2.43	1.52	.092	.112	.806	
K7	I can be more visible when I use a reflector when I'm riding my bike	3.55	1.36	.677	.494	.766	.745
K8	To avoid injury, you have to do some stretching exercises for 6–10 min before riding your bike	2.93	1.48	.482	.311	.770	
K9	Riding a bicycle that is suitable for the road structure prevents falls	3.77	1.28	.699	.538	.767	.733
K10	The type of handlebar on a bike is important in reducing injury in a fall	3.51	1.32	.718	.559	.763	.727
K11	Tying my shoelaces tightly will prevent me from tripping and falling	4.18	1.12	.423	.257	.776	
K14	Using safety equipment will reduce accidents and injuries when you fall	3.30	1.62	.036	.047	.814	
K23	I get anxious if I ride a bicycle with no back reflector	3.40	1.48	.421	.202	.776	
K25	It is dangerous to race with vehicles in traffic	4.01	1.39	.286	.160	.787	
	The Cons Scale of Decisional Balance	**$\bar{x}$**	**sd**	**r_{jx}**	**r**	**α^1**	**α^2**
K12	My friends make fun of riders who wear helmets	2.05	1.43	.678	.528	.820	.773
K13	I would get tired if I do exercises before cycling	2.69	1.43	.358	.143	.844	
K15	Wearing gloves when I'm cycling would make my hands sweat	2.86	1.48	.484	.277	.824	
K16	Wearing a knee-guard is uncomfortable	2.71	1.53	.711	.560	.817	.766
K17	Doing cooling-off exercises is a waste of time	2.71	1.54	.730	.584	.816	.760
K18	A bicycle helmet is much more expensive than I can afford	2.39	1.50	.517	.307	.822	
K19	The bicycle handlebar is good for carrying things/loads	2.55	1.46	.500	.281	.823	
K20	Wearing a helmet prevents me from looking nice	2.29	1.50	.726	.583	.816	.760
K21	There is no type of helmet I like	2.52	1.57	.570	.410	.889	
K22	Wearing elbow pads is a waste of time	2.37	1.50	.628	.495	.815	
K24	I like to see people watching me as I do some acrobatic moves.	2.53	1.52	.717	.509	.822	.777
K26	It's enjoyable to look around when I'm cycling	3.05	2.76	.262	.103	.854	
K27	It's fun to jump over hillocks on my bike	2.67	1.63	.673	.554	.820	.767
	The Self-Efficacy Scale	**$\bar{x}$**	**sd**	**r_{jx}**	**r**	**α^1**	**α^2**
Ö1	Even If I feel full of energy; I believe I will not cycle above speed limits	3.26	1.54	.301	.509	.838	
Ö2	Even if I am happy, I believe I will not listen to music with two headphones when I'm cycling.	3.09	1.63	.196	.361	.848	
Ö3	Even when I'm feeling cheerful, I believe I will keep both my hands on the handlebars.	3.26	1.66	.261	.448	.842	
Ö4	I believe that I will do some stretching exercises after riding my bike, even if I'm tired	2.59	1.54	.330	.489	.839	
Ö5	Even if I'm feeling angry, I believe I will follow the traffic rules when I'm cycling	3.97	1.35	.635	.612	.832	.753
Ö6	Even if I feel impatient, I believe I will give pedestrians the right of way when I'm cycling	4.14	1.23	.732	.491	.838	.776
Ö7	Even when I'm in a rush, I believe that I can ride my bike without weaving around the vehicles on the road	3.57	1.54	.209	.419	.843	
Ö8	I believe I will wear a helmet even though it may mess up my hair	3.19	1.62	.524	.385	.837	
Ö9	Even if I'm hungry, I believe I won't eat when I'm cycling.	3.68	1.49	.627	.525	.835	.769
Ö10	I believe that when I buy protective equipment (even though it may be expensive), I will make sure it's up to standards	3.50	1.45	.330	.503	.838	
Ö11	I believe I won't let anyone sit on the front pipe of my bike.	3.84	1.41	.679	.521	.836	.770
Ö12	Even though it's difficult to do, I believe I will keep my knees parallel when I'm turning the pedals	3.61	1.37	.669	.589	.836	.757
Ö13	I believe I can shift my weight back to stabilize my speed when I'm biking down a ramp	3.61	1.38	.718	.489	.839	.776
Ö15	I believe I will not use the roadway if there is a bicycle path	4.10	1.35	.197	.392	.844	

Note. $\bar{x}$ = Items mean, sd = standard deviation, rjx = Items-total score correlations, r = corrected item-total correlation, α1 = Cronbach's alpha if item deleted **α^2**= Cronbach's alpha if item deleted (**when gray items were removed)**.

BCPS, 0.658-0.718 for PSDB, 0.673-0.730 for CSDB and 0.627-0.732 for SES (Tables 4 and 5). In terms of scale validity, it was determined that correlation coefficients were significant in all scales.

Since the item-total correlation coefficients in the study were above 0.46, the analysis showed that all of the scales were valid in terms of the measure.

Item variances: Variances of items were calculated on the basis of standard deviation. It was seen that the items that displayed the highest variances in each scale were items numbered S34, S37, K7, K27, Ö3, Ö9 (Tables 4 and 5).

3.2. Reliability results and discussions

The most commonly employed techniques to examine the reliability of a scale are internal consistency, test-retest reliability and Intraclass Correlation Coefficient analysis (Tezbaşaran, 2008). In addition to these methods, Hotelling's T2 and floor-ceiling effect analysis were used in this study.

3.2.1. Consistency

Cronbach's Alpha: In the literature, a Cronbach alpha value of 0.60–0.80 is accepted as good reliability and 0.80–1 as high reliability (Karagöz, 2016). The internal consistency reliability coefficients of the scales were $\alpha = 0.794$ for CCPS, $\alpha = 0.823$ for BCPS, $\alpha = 0.772$ for PSDB, $\alpha = 0.798$ for CSDB and $\alpha = 0.783$ for SES. According to these criteria, of the TTM scales, BCPS was seen to show high reliability and the CCPS, PSDB, CSDB and SES to have good reliability.

Item analysis: The standard deviation values, item-total score correlations, inter-item correlations and alpha values when an item was deleted as part of the item analysis are shown in Tables 4 and 5 Average inter-item correlation coefficients and mean item-total score correlation coefficients were calculated.

The most commonly used item analysis techniques are Item Difficulty and Item Discrimination Analysis (Büyüköztürk et al., 2017). Item difficulty is used in scales with questions that have two options. Multiple choice questions are not used in measures of behavior (Erkuş, 2013).

For this reason, the item difficulty index was not evaluated in this study. Item discrimination however was examined in the context of validity since this parameter provides information about a scale's validity. The average inter-item correlation coefficients and average item-total correlation coefficients were assessed for reliability.

Average inter-item correlation coefficients: The average of item correlation coefficients indicates internal consistency. This average shows to what degree the scale items correlate with each other (Şencan, 2005). Average correlations were found as follows: CCPS, 0.466; BCPS, 0.565; PSDB, 0.517; CSDB, 0.553; SES, 0.537. The scale that displayed the highest level of correlation between items was BCPS.

Average total score correlation coefficients: This is the correlation between each item score and the overall scale assessment. This is an indication of internal consistency (Şencan, 2005). Average correlations were found as follows: CCPS, 0.532; BCPS, 0.694; PSDB, 0.684; CSDB, 0.705; SES, 0.676. The scale that displayed the highest level of correlation between the item scores and the overall score was CSDB.

3.2.2. Invariance (consistency over time)

Test re-test: In testing for reliability, the power of the scales to provide sensitive, consistent measurements that would be consistent over time was evaluated. The invariance of a scale over time is an indication of its consistency (Büyüköztürk, 2018; Büyüköztürk et al., 2017). On the other hand, the test-retest technique has certain disadvantages such as the memorization effect, the implementation effect and level of difficulty (Şencan, 2005). In order to test consistency over time, all of the scales were administered to the 86 students 15 days apart.

Using the paired samples *t*-test, the following significant values were found: $p = 0.359$ for CCPS, $p = 0.742$ for BCPS, $p = 0.799$ for PSDB, $p = 0.267$ for CSDB, and $p = 0.764$ for SES, indicating consistency over time and no difference between the scales. It was found that the scales were reliable over time.

3.2.3. Scoring consistency

Intraclass correlation coefficient: This is the degree of agreement between measures of more than one taken by the same rater. This depends not on the instruments used for measuring but on the researcher. In numerical measures, this is assessed by looking at the intraclass correlation (Mehta et al., 2018). Consistency values between two measures of 0.60–0.80 shows good reliability, a value of over 0.80 points to excellent reliability (Erkuş, 2012; Tezbaşaran, 2008).

Intraclass correlation coefficients of the scales at a 95% confidence interval were $\alpha = 0.832$ for CCPS, $\alpha = 0.783$ for BCPS, $\alpha = 0.809$ for PSDB, $\alpha = 0.873$ for CSDB and $\alpha = 0.790$ for SES. It was observed in the study that agreement of the scales was at a good level for BCPS and SES, and at an excellent level for the others.

3.2.4. Other reliability analyses

Hotelling's T Squared analysis: Hotelling's T Squared test was employed in the study to investigate whether the adolescents responded according to their own views or answered under the influence of the researcher or others (Şencan, 2005).

Hotelling's T Squared values were 725.894 for CCPS, 248.982 for BCPS, 102.738 for PSDP, 122.367 for CSDP, 83.157 for SES ($p = 0{,}00$). It was concluded that the difference between the question mean scores was significant and scales did not exhibit any response bias.

Floor-ceiling effect analysis: According to Pontes and Griffiths (2015), floor-ceiling rates should not be over 15%. This would indicate an undesirable floor-ceiling effect (Pontes and Griffiths, 2015). When the distribution of scores was analyzed, it was seen that all of the scales had floor-ceiling effects of below 15%, showing that there was no floor-ceiling effect in the distribution of scores. The scales were thus homogeneous.

3.3. Descriptive findings

The adolescents' situations in the stages of change were assessed in terms of safe bicycle riding. Accordingly, of the adolescents, 24.5% were in the precontemplation, 8.9% in the contemplation, 5% in the preparation, 11.9% in the action and 49.7% were in the maintenance stages. The mean scores of the adolescents on the scales, their Standard Deviation values, mean item scores and Standard Deviation and Standard Error values are presented in Table 6.

When the items with the highest loadings were examined according to the CFA (Figs. 1–5), it was noted that the adolescents' highest scores in the cognitive and behavioral processes of change scales were recorded for S34 = 0.63 and S35 = 0.80, showing that the adolescents had progressed in the stages of change by using safety equipment.

Their highest score on the pros perception scale was in K9 = 0.72; this showed that in their decision to ride a bike safely, they were motivated to choose a bicycle that was suitable for the type of road they would be traveling. Their score of K17 = 0.68 on the cons perception scale showed that doing cooling down exercises proved to be a barrier to safe bicycle riding.

The adolescents' highest score of Ö5 = 0.74 on the self-efficacy scale showed that following traffic rules and regulations contributed to their self-confidence.

4. Strengths and limitations

Safe bicycle riding was comprehensively described for the first time in this study. The TTM-based safe bicycle riding scales in the study were developed for the first time on the basis of expert opinions and using the Delphi technique. As the scales are based on TTM, they can be used to evaluate the stages of behavioral change, the processes of change, and the levels of change. The scales developed can be used to prepare information, attitudinal and behavioral content for bicycle riding training as well as in behavioral assessment.

Individuals (e.g., school nurses, parents) or organizations (e.g., municipalities, sports clubs) involved in teaching bicycle riding can use these scales as guidelines. The scales can be tested in other age groups. Pre- and post-measures of safe bicycle riding behaviors and views of safe bicycle riding behaviors should be analyzed to better understand the value of safe bicycle riding behavior interventions based on the TTM model. Feedback, education, media campaigns, roleplaying, personal testimonies, messages, empathy training, documentaries, motivational interviewing and family involvement are interventions that may impact progression through the stages (Armstrong et al., 2011; Erdem and Erol, 2020; Han et al., 2017; Heller et al., 2013) and should be used to engage participants.

This research was limited by the reliance on self-report data and by the fact that the developed scales were planned only for adolescents.

5. Conclusions and recommendations

This study supported the underlying structure, internal consistency reliability, external validity, and measurement invariance of the measures in a population-based adolescent sample. The TTM-based safe bicycle riding scales developed for adolescents in this study are all single-dimensional. The Cognitive Change Process Scale determines levels of knowledge and attitudes about safe bike riding. The Behavioral Change Process Scale assesses behaviors regarding safe bike riding. The Pros/Cons Scales of Decisional Balance assesses adolescents' perceptions of the pros/cons of safe bike riding. The scales also show the factors motivating and acting as a barrier to safe bicycle riding. The Self-Efficacy Scale is for assessing adolescents' self-confidence about safe bike riding, even though the individual may encounter various barriers.

At the end of the research, it was seen that 24.5% of the adolescents were in the precontemplation stage of change of the

Table 6
Mean scores of the Scales and Standard Deviation values and item mean scores and Standard Deviation, Standard Error Values.

Scales	Items	Min to Max	Total Scores		Item Scores		
			Mean	Sd	Mean	Sd	$sh_{\bar{x}}$
CCPS	10 Items	11-50 (10–50)*	35.67	8,24	3.6	0.91	0.04
BCPS	7 Items	7-35 (7–35)*	21.42	7.27	3.06	1.03	0.04
PSDP	6 Items	6-30 (6–30)*	22.38	5,3	3.73	0.88	0.03
CSDP	6 Items	6-30 (6–30)*	14.98	6,48	2.49	1.08	0.04
SES	6 Items	6-30 (6–30)*	25.48	6.59	3.64	0.94	0.04

Note. CCPS: The Cognitive Change Process Scale, BCPS: The Behavioral Change Process Scale, PSDP: The Pros Scale of Decisional Balance, CSDP: The Cons Scale of Decisional Balance, SES The Self-Efficacy Scale, Sd: Standart Deviation, Sh_{x}: Standart Error, *these values show the minimum and maximum scores of the scales.

Transtheoretical Model about safe bicycle riding. The adolescents' con scores about safe bike riding were below the mean, while the cognitive and behavioral processes, pros and self-efficacy scores were above the mean.

This innovative study is the first in the literature to make a multi-faceted and integrative investigation into safe bicycle riding based on a theoretical model. The research provides important data on the factors that may influence safe bicycle riding.

The study incorporated a multidimensional model to apply to all constructs of the TTM to better understand behavior change in terms of using a bicycle safely. This is why future research should seek to understand why some people stop riding bicycles safely, even after successfully progressing through the early stages of change to reach Action and/or Maintenance (known as Relapse, which is the regression from the Action or Maintenance stage of change to an earlier stage of change). Research on relapses from TTM-based safe bicycle riding would further the understanding of how people move through the stages of acquiring safe bicycle riding behaviors over time.

At the same time, the measures developed can be used in exploring the reasons behind bicycle accidents and injuries.

Author contribution

Study Design; ÖE, SE.
Data Collection and Analysis; ÖE, SE.
Manuscript Writing; ÖE, SE.

Financial disclosure

We declare that no financial support or relationships.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jth.2020.101006.

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