DEVELOPMENT, VALIDATION AND RELIABILITY OF THE CHRONONUTRITION PROFILE

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ABSTRACT

Chrononutrition, or the circadian timing of food intake, has garnered attention as a topic of study due to its associations with health (e.g., weight gain); however, a valid assessment of chrononutrition in daily life has not yet been developed. The present study therefore aimed to develop and validate both a diary and questionnaire version of the Chrononutrition Profile which assess 6 components of chrononutrition that have been associated with poor health (breakfast skipping, night eating, eating window, evening latency, largest meal, and evening eating). The measure demonstrated preliminary evidence of test-retest reliability and convergent validity, though concurrent validity was not interpretable. Based on analyses, the final diary and questionnaire versions of the CP assess 5 components of chrononutrition: breakfast skipping, night eating, eating window, evening latency, and evening eating. This measure offers health care professionals, researchers, and stakeholders a cost-effective method of evaluating chrononutrition and identifying targets for health improvement.

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INTRODUCTION

Traditional dietary recommendations regarding *what* and *how much* food to consume (e.g. ~1.5 to 2.5 cups of vegetables per day; ~2.5 to 3 cups of dairy per day) have been well-established (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). However, *when* food intake occurs throughout the 24-hour day – also known as chrononutrition – may be just as important for health (for reviews, see Asher & Sassone-Corsi, 2015 and Eckel-Mahan & Sassone-Corsi, 2013). Chrononutrition, or the circadian timing of food intake (Arble, Bass, Laposky, Vitaterna, & Turek, 2009) is a novel field of research which has gained considerable attention as a topic of study. To date, much of the work on chrononutrition has been laboratory-based; thus, a validated self-report measurement of chrononutrition in daily life has not yet been developed. This paper will begin with a review of relevant literature and will then detail a study which designed and tested a questionnaire and diary assessment of chrononutrition.

Biological Clock Basics

Nearly all living organisms undergo ~24-hour-long cycles of physiological and behavioral fluctuations that occur in synchrony with Earth's rotation on its axis (Dunlap, Loros, & DeCoursey, 2004). These "circadian rhythms" (derived from the Latin words *circa* and *diem*, meaning "about a day") are, by definition, not precisely 24 hours. Therefore, the body's circadian system must rely on environmental and behavioral Zeitgebers (German for "time-givers") such as temperature cycles and social cues to synchronize, or entrain, to the 24-hour day. Zeitgebers can bring about many changes in the body, including fluctuations in hormone secretion (e.g. cortisol, melatonin), neurotransmitter activity, body temperature, and behavior (Aschoff, 1965; Roenneberg et al., 2007; Eckel-Mahan & Sassone-Corsi, 2013). Such

physiological responses to Zeitgebers (e.g. light exposure, food availability) ensure that the body meets the various energy demands of the 24-hour day (Duffy & Czeisler, 2009; Johnston, 2014). The environmental light/dark cycle is considered the most influential Zeitgeber as it provides the strongest signal for entrainment; the suprachiasmatic nucleus (SCN), also known as the central clock or the master circadian pacemaker, primarily responds to these cues. Additionally, the structure is responsible for regulating and transmitting information from light/dark cues to the body's peripheral clocks.

These peripheral clocks are located within nearly every cell and tissue throughout the rest of the body (e.g. gastrointestinal tract (Konturek, Brzozwski, & Konturek, 2011), cardiovascular system (Guo & Stein, 2003) (for comprehensive review, see Dibner, Schibler, & Albrecht, 2010). Peripheral clocks are also influenced by both nutrient intake and feeding/fasting cycles (Johnston, 2014). For example, feeding/fasting cycles are particularly vital to entrain the liver clock to the environment, and nutrients can affect the phase of the liver clock, as the liver clock appears to operate independently from the central clock and light/dark cycles (Hara et al., 2001; Stokkan, Yamazaki, Tei, Sakaki, & Menaker, 2001).

In fact, recent work suggests that the circadian timing of food intake (i.e. chrononutrition) is critical for health; mechanisms underlying the association between chrononutrition and health likely parallel those underlying the association between nutrition and health.

Nutrition, Chrononutrition, and Health

As shown in Figure 1, nutrition and chrononutrition are complementary yet distinct constructs which may impact health. Biological, psychological, and social factors may significantly impact the numerous behavioral factors which are traditionally associated with nutrition, such as consumption of a high-fat diet or excess calorie intake. For example, both

positive and negative emotions have been related to increased calorie intake (Evers, Adriaanse, de Ridder, & de Witt Huberts, 2013; Strien et al., 2013). Furthermore, eating is often a social behavior. Eating with others may lead to excess calorie intake because of social norms and inattention to the food consumed (Higgs & Thomas, 2016).

Biological, psychological, and social factors may also influence behavioral components of chrononutrition. For example, cohabiting couples may choose to eat their main meal together in the evening (i.e. dinner/supper) after finishing work for the day (Kremmer, Anderson, & Marshall, 1998). Additionally, greater energy intake at breakfast has been linked to improved mood (Veasey, Haskell-Ramsey, Kennedy, Tiplady, & Stevenson, 2015). Plasma hormone levels of both ghrelin and leptin have demonstrated circadian rhythmicity and have been shown to play a role in meal timing throughout the 24-hour period. Ghrelin and leptin stimulate and suppress appetite, respectively. The body's ghrelin levels typically increase before eating events (Cummings et al., 2001; Tsujino & Sakurai, 2012). A peak in leptin release occurs around midnight, during the typical sleep time, while a trough occurs in the mid-to-late morning, when the body is becoming active again (Schoeller, Cella, Sinha, & Caro, 1997; Tsujino & Sakurai, 2012).

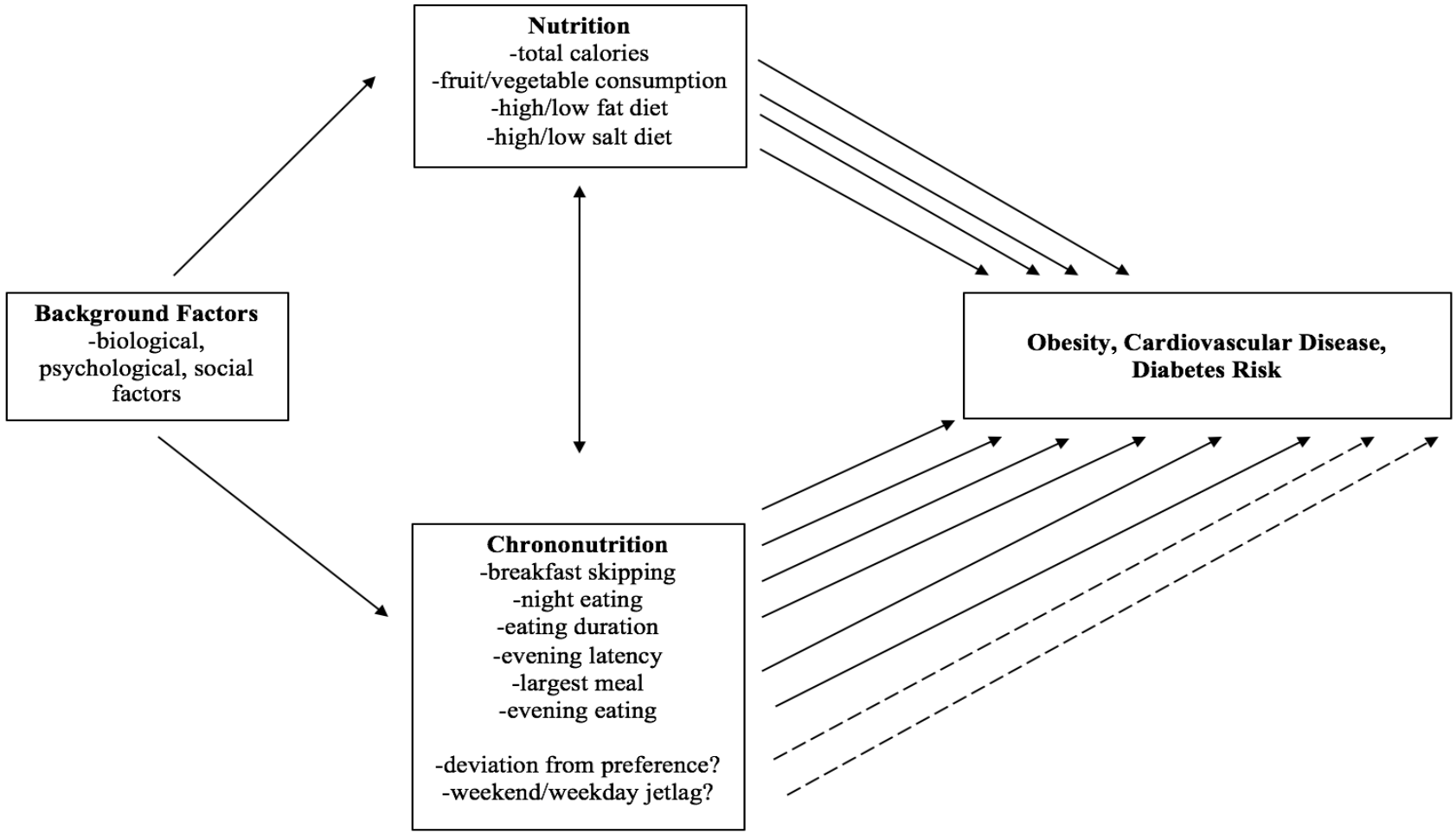

Figure 1. Theoretical model of the relationship between chrononutrition, nutrition, and health outcomes.

Behavioral aspects of nutrition have been associated with various chronic diseases (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015); the pathways between nutrition behaviors and health outcomes have been well-established. A high-fat diet tends to be calorically dense and only offers short-term satiety, often contributing to overconsumption, subsequent weight gain, and obesity (Golay & Bobbioni, 1997; for review, see Bray & Popkin, 1998). A high-fat diet may also lead to greater low-density lipoprotein cholesterol (LDL-C) levels in the body, which has been linked to greater risk of cardiovascular disease (CVD) (Castelli, Anderson, Wilson, & Levy, 1992; for review, see Wadhera, Steen, Khan, Giugliano, & Foody, 2016).

Researchers have also examined health outcomes associated with chrononutrition in laboratory studies of both animal models and humans. Animal models have been utilized in chrononutrition studies to examine the relationship between circadian rhythmicity and metabolism at multiple levels, from individual molecules to behavior. For example, compared to non-mutant mice, mice with a genetic mutation of the *Clock* transcription factor were less responsive to Zeitgebers and expressed considerably weakened diurnal rhythms (Turek et al., 2005). Mutant mice tended to consume a greater amount of food overall, and notably, a larger percentage of their daily food intake occurred during abnormal times; as a result, mutant mice were more likely than non-mutant mice to become obese (Turek et al., 2005). Simply altering the timing of food intake to an inappropriate time, such as feeding during the typical sleep time rather than during the typical wake time, has also led to increased body weight in mice - even when caloric intake is identical between conditions (Arble et al., 2009). Relatedly, a restricted eating window (e.g., 8 hour window) can lessen negative effects of an unhealthy diet - such as weight gain, inflammation, and insulin resistance - in both mice (Chaix, Zarrinpar, Miu, &

Panda, 2014) and humans (Gill & Panda, 2015). Proper timing of feeding/fasting in relation to the body's energy needs can enhance metabolic health (for review, see Potter, Cade, Grant, & Hardie, 2016), while inappropriate timing of feeding has been associated with impaired physical and mental health (for review, see Reid, Baron, & Zee, 2014). Overall, these laboratory findings suggest that the timing of food intake may play a significant role in health. Specifically, recent research has highlighted certain behavioral patterns which are relevant to chrononutrition.

Behavioral Indicators of Chrononutrition

A review of the extant literature has highlighted 6 specific behavioral patterns likely to impact one's chrononutrition profile including 1) night eating, 2) time-restricted feeding, 3) breakfast consumption, 4) timing of the largest meal, 5) timing of evening eating, and 6) time between eating and bedtime. Evaluation of such factors will be central to the development of a valid chrononutrition assessment.

Night eating. The majority of empirical evidence regarding nighttime eating in humans comes from the study of night eating syndrome (NES). NES was first described by Stunkard et al. (1955) and has since been categorized as an "Other Specified Feeding or Eating Disorder" in the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; *DSM-5*; American Psychiatric Association, 2013) The disorder is typically characterized by eating large amounts of food in the evening; waking in the night to eat; insomnia, impacting either the ability to fall asleep or stay asleep; and lack of appetite in the morning (O'Reardon, Peshek, & Allison, 2005). More recently, the diagnostic criteria for NES has been expanded to include distress or functional impairment (Allison et al., 2010). NES is distinct from sleep-related eating disorder (SRED) because NES involves a conscious decision to consume food, whereas SRED is a form of parasomnia characterized by eating during sleep (O'Reardon et al., 2005).

Circadian desynchrony of the feeding-fasting/sleep-wake cycles is likely an underlying cause of NES (Schenck, 2006). Such misalignment may account for the associations between NES and many negative health outcomes such as anorexia nervosa, bulimia nervosa, stress, anxiety, depression, poor sleep, and obesity (for review, see Cleator, Abbott, Judd, Sutton, & Wilding, 2012). Research on night eating has laid the foundation for further dietary research within the field of chrononutrition by offering insight into the health implications of the timing of eating.

Time-restricted feeding. Time-restricted feeding (TRF), a term which refers to food intake within a designated time frame (e.g. 8- or 10-hour window) during the 24-hour day (Rothschild, Hoddy, Jambazian, & Varady, 2014), is also relevant to the field of chrononutrition. TRF has been primarily examined in animal models. Notably, TRF has been shown to mitigate the negative metabolic effects of a high-fat diet in mice; mice with *ad libitum* access to food gained almost 30% more weight and had worse health compared to mice with food access restricted to 8 hours, although caloric intake was identical across experimental groups (Hatori et al., 2012). Similarly, a 9-hour feeding window within typical waking hours reduced inflammation and reduced insulin resistance, regardless of the diet composition (e.g., fat and sucrose diet, normal diet, high-fat diet, high-sucrose diet) (Chaix et al., 2014). Animal studies on TRF have pioneered much of the current work on human chrononutrition.

To mimic the human "weekly schedule" of differing temporal eating patterns on weekdays and weekends, Chaix et al. (2014) assigned one group of mice to five days of TRF and two days of *ad libitum* food access, and another group to *ad libitum* food access, for 12 weeks. Both groups were fed an identical high-fat diet. Mice in the so-called "weekly schedule" group experienced half as much weight gain as those who consumed an *ad libitum* high-fat diet.

Because evidence from animal models may not generalize to human health, researchers have begun to assess this phenomenon in humans. Gill and Panda (2015) conducted a pilot intervention in which overweight participants with a 14 hour baseline eating window restricted their eating to 10 to 11 hours for 16 weeks; participants lost weight and reported greater subjective energy level and sleep satisfaction, and these changes were even maintained for one year after the intervention began.

Breakfast consumption. The timing of breakfast consumption – or lack of breakfast consumption – has also been studied in relation to health and to the timing of other meals. For example, skipping breakfast has been associated with a 4.5 times greater likelihood of obesity (Ma et al., 2003). Compared to American adults who consumed breakfast, American adults who did not consume breakfast reported earlier and more energy-dense lunches (Kant & Graubard, 2015) and more energy consumption at dinner (Almoosawi, Vingeliene, Karagounis, & Pot, 2016).

Recent literature has provided conflicting evidence on the health effects of breakfast skipping (for review, see St-Onge et al., 2017). This may be because a consistent definition of breakfast skipping has not yet been defined. Skipping breakfast three or more days per week may not be associated with increased risk of overweight (Lee et al., 2016), while skipping breakfast five or more days per week has been associated with abnormal cortisol rhythms and increased blood pressure (Witbracht, Keim, Forester, Widaman, & Laugero, 2015). Furthermore, the negative effects of skipping breakfast may be more pronounced for habitual breakfast eaters than for habitual breakfast skippers (Thomas, Higgins, Bessesn, McNair, & Corner, 2015). Though more evidence is needed to understand the complexities of this construct, breakfast consumption should be considered in a measure of chrononutrition, as breakfast is typically the first meal

consumed after a night of sleep (i.e. the longest fasting period of the day) and therefore establishes the time of the body's liver clock (Hirao et al., 2010).

Temporal eating and sleeping patterns. Temporal eating patterns throughout the 24-hour day have recently become a widely-studied topic in health research. Though traditional dietary research has typically focused on dietary intake, evidence on the timing of nutrient consumption is limited (for review, see Leech, Worsley, Timperio, & McNaughton, 2015). Eating earlier in the day (rather than later) has been linked to better metabolic outcomes and lower total daily caloric intake (Dattilo, Crispim, Zimberg, Tufik, & de Mello, 2010; Jakubowicz, Barnea, Wainstein, & Froy, 2013; Reid et al., 2014). However, consumption of food or drinks after 11:00 P.M. has been related to weight gain (Gluck, Venti, Salbe, & Krakoff, 2008). Evening chronotypes (i.e. "night owls") may be more likely than morning chronotypes (i.e. "morning larks") to consume more calories later in the day (Fleig & Randler, 2009; Sato-Mito, Shibata, Sasaki, & Sato, 2011).

Research has examined the relationship between the timing of eating and the sleep-wake cycle as well. Participants with a later sleep midpoint (represented as the time at the middle of the sleep interval) got less sleep and ate meals later, compared to participants with an earlier sleep midpoint (Baron, Reid, Kern, & Zee, 2011). Moreover, Baron and colleagues (2011) found that those with a later sleep midpoint typically had a less healthy diet and also consumed more calories in the evening than participants with an earlier sleep midpoint. Participants with experimentally-restricted sleep (4h) and a late bedtime consumed more calories than control subjects did, perhaps because participants with the later bedtime needed to compensate for the lost sleep (Spaeth, Dinges, & Goel, 2013).

Meal timing relative to sleep has also been examined in recent research. Evening latency, or the duration of time between the last eating event and sleep onset, may be related to health. Specifically, as opposed to eating within six hours of bed, eating within two hours of bed has been associated with increased acid reflux symptoms (Piesman, Hwang, Maydonovitch, & Wong, 2007). Ma et al. (2003) and Reid et al (2014), however, did not find significant associations between body mass index (BMI) and morning latency, or the duration of time between wake time and the first meal of the day.

Finally, the timing of the largest (i.e. largest amount) intake of food has been reliably associated with both chronotype (preference for sleep/wake at a particular time of the 24-hour day) and overall health (Fleig & Randler, 2009; Paine, Gander, & Travier, 2006; Sato-Mito et al., 2011). For example, individuals who consumed the largest meal in the evening (i.e. dinner/supper) had a higher BMI than those who consumed the largest meal for breakfast or lunch (Kahleova, Lloren, Mashchak, Hill, & Fraser, 2017).

Taken together, the current literature identifies several key components of chrononutrition and their implications for health. Chrononutrition, though complementary to the traditional concept of nutrition, is a clearly distinct construct that is centered around *when* eating occurs. Although many dietary and sleep assessments have been developed and tested for use in research and practice, a comprehensive assessment of behavioral chrononutrition patterns is not presently available.

Purpose of Present Study

Though the vast majority of existing measures do not assess behavioral indicators of chrononutrition, prior dietary and sleep research and assessment work may inform some aspects of chrononutrition. While some existing dietary measures do ask participants to report the timing

of their eating events (e.g. ASA24), these measures also impose significant participant burden and may take as long as 30 minutes to complete because they are primarily focused on assessing the nutrients individuals consume. Sleep assessments such as the Pittsburgh Sleep Quality Index (PSQI) measure numerous indicators of sleep quality, including bed time and wake time, but do not ask participants about their food intake.

Thus, existing dietary and sleep assessments are not tailored to measure *when* eating occurs and therefore cannot provide a complete chrononutrition profile. Recent experimental studies examining the circadian timing of food intake in humans and animals have provided valuable insight into the importance of appropriate timing of eating. However, these studies do not provide detailed information regarding humans' natural patterns of chrononutrition outside of the controlled research laboratory. Validated measures that are designed to assess specific behavioral factors of one's chrononutrition profile could provide health care professionals with a cost-effective method to target both prevention and treatment interventions for the numerous health consequences associated with inappropriate timing of eating. Rather than replacing the well-established nutritional guidelines, a chrononutrition assessment could supplement these and provide additional information on individuals' eating patterns, offering a comprehensive approach to nutritional health.

Thus, the purpose of the present study was to develop and evaluate the Chrononutrition Profile (CP). The CP is available in a questionnaire (CP-Q) and diary (CP-D) format to maximize the flexibility of assessment options and allow individuals to tailor data collection to their specific needs. The CP is built upon a foundation of empirical evidence which identifies several behavioral indicators that are likely associated with chrononutrition. The CP is designed to serve as a thorough yet concise assessment which captures each of these aspects of

chrononutrition just as well as the numerous existing sleep and dietary measures, without imparting significant participant burden. Therefore, gold standard assessment methods from the fields of nutrition, sleep, and health research were utilized to evaluate and refine the CP.

METHOD

Expert insight, examination of relevant literature and related measures, and one-on-one participant interviews led to the development of the Chrononutrition Profile - Questionnaire (CP-Q) and the Chrononutrition Profile - Diary (CP-D). Validity and reliability of the final version of the CP-Q and CP-D were tested through online surveys. Study procedures and materials were approved by the Institutional Review Board at North Dakota State University.

Procedure

Instrument development. An initial chrononutrition questionnaire and diary were developed to assess individuals' comprehensive chrononutrition profile. Key components of the initial measures were: a) timing of first and last eating events, b) eating window from first eating event to last eating event, c) bedtime and wake time, d) evening eating, e) frequency of night eating, and f) meal skipping. These topics have been associated with copious negative health outcomes, as previously described. Items in both measures were based on expert insight and examination of relevant literature and related measures, and initial measures were evaluated in one-on-one interviews.

Experts in dietetics, eating disorders, circadian rhythms, scale development, and health psychology from North Dakota State University and Sanford Research in Fargo, North Dakota, were consulted to provide initial feedback on the content of the measure.

Examination of relevant literature. Because an in-depth measurement of chrononutrition profile did not yet exist, recent dietary, eating disorder, circadian rhythm, and chrononutrition literature was examined extensively to determine the chrononutrition topic areas most relevant to health; these topics are described above.

Examination of related measures. Existing dietary, eating disorder, and chronotype self-report measures were also reviewed. This allowed for identification of commonalities among these diverse areas and provided insight into aspects of chrononutrition which are not currently assessed by measures within the above research domains. For example, chronotype measures such as the Munich ChronoType Questionnaire (MCTQ) (Roenneberg et al., 2007) evaluate the phase of synchronization through sleep/wake timing of both free and work days. The assessment of behavior on both workdays and free days was a foundational aspect of the CP development, as individuals commonly report diverse sleep/wake and feeding/fating patterns between workdays and free days. The MCTQ does not assess the circadian timing of food intake, however.

Dietary composition may be assessed through an array of methods. *What* participants are eating may be measured objectively (e.g. nutritional biomarkers (Kuhnle, 2012) or subjectively (e.g. Rapid Eating and Activity Assessment for Patients (REAP) (Gans et al., 2003); National Health and Nutrition Examination Survey (NHANES) (Centers for Disease Control and Prevention (CDC))). The NHANES is administered to a large, nationally representative sample, but this survey method is prone to recall bias; specifically, respondents tend to vastly under-report their dietary intake (Archer, Hand, & Blair, 2013; Kye et al., 2014). The 24-hour dietary recall (24HR) is a widely-used, structured interview designed to assess an individual's complete food and beverage intake over the past 24 hours (Dietary Assessment Primer, 24-hour Dietary Recall (24HR) At a Glance). The 24HR also requires interviewers to complete extensive training (Shim, Oh, & Kim, 2014). Additionally, existing dietary intake measures may be prone to impart significant participant burden (Shim et al., 2014).

One-on-one interviews. 20 individuals completed an in-person interview. Participants received course credit as compensation for their participation in the interview. Students were

eligible to participate if they were 18 years of age or older. No other exclusion criteria were used. The principal investigator (AE) interviewed each participant individually in a private room. Participants were given a paper copy of the questionnaire and diary items and asked to read each item aloud and talk through their thought process as they responded to each item. The interviewer would probe for additional clarification or feedback as necessary. Participant feedback during the interviews was noted and was used to develop the next version of the measure.

Revision process. The initial questionnaire used for interviews consisted of 18 items designed to assess general patterns of chrononutrition, while the initial diary consisted of 22 items and was meant to examine day-to-day variation in chrononutrition patterns (see Appendices A and B). Interviews with participants informed changes to wording of items in the initial measures. The pilot questionnaire measure asked participants when they consumed their "first meal or snack of the day" and their "last meal or snack of the day"; 17 of 20 participants expressed confusion on whether to report a meal or snack for these items. When asked about alternative wording options, 15 of 20 participants indicated that the phrase "eating event" was clearer than "eating episode" and the initial "first/last meal or snack of the day". Therefore, items in the final version of the questionnaire instead asked participants about their first and last "eating event" of the day. However, because interview participants also indicated that "eating event" may be ambiguous (e.g., 3 participants thought this only referred to meals and 2 participants did not think drinks should be reported), "eating event" was described for participants in the final version of the questionnaire: "The term 'eating event' refers to any time you eat something that contains calories. For example, this could be a meal, a snack, or a drink".

This description of an eating event was based off existing nutrition literature and dietary assessment measures.

Other items were revised as well. Initial measure items asking about the time participants "go to bed" were revised to instead ask when they "fall asleep" to provide further clarity, as 12 participants reported that "going to bed" was actually when they fell asleep; these individuals felt that they were more accurate at reporting the time they fell asleep, and this value is more relevant to the goals of the measure. Additionally, 19 of 20 participants indicated that their responses for the initial questionnaire were the average times that they went to bed, ate, and the average frequency that they woke in the night to eat or ate breakfast. Hence, the items of the final questionnaire were revised to ask participants to report average values. The initial diary asked participants whether they were ill today, but to encompass additional factors which could affect one's timing of eating, the final version of the diary also asked participants to report whether they considered today a weekday or a weekend, and whether today was a normal day. With the aforementioned changes implemented, the original version of the questionnaire (the CP-Q) contained 18 items and the original version of the diary (the CP-D) contained 24 items (Appendices C and D). These versions were evaluated in the present study. Scoring procedures were thus established for the CP to represent the 6 primary behaviors of one's chrononutrition profile.

Chrononutrition Profile scoring. Scoring methods for the CP-Q and CP-D vary slightly, but overall both versions of the CP provide scores on each of the 6 chrononutrition behaviors and a total CP score. Scoring procedures are summarized in Table 1. Briefly, continuous values are calculated and/or extracted for each chrononutrition behavior (i.e., eating window, breakfast skipping, evening latency, evening eating, night eating, largest meal).

Because the CP-Q measures behaviors for weekdays and weekends separately, additional calculations are required to provide a weighted aggregate score that better represents weekly patterns. Specifically, values are calculated separately for weekdays and weekends, then values are weighted to represent 5 weekdays and 2 weekend days. For example, if the weekday eating window is calculated as 10 hours and the weekend eating window is calculated as 14 hours, the aggregate eating window is estimated as 11.14 hours ((10 hours * 5 days + 14 hours * 2 days)/7 days). Alternatively, researchers could choose to keep weekday and weekend day calculations separate and/or examine the discrepancy between them. However, the primary purpose of the CP is to identify overall chrononutrition patterns, and therefore we recommend the weighted aggregate score. With the CP-D, aggregate values can be estimated across all days of data collection (or individual investigators may decide to aggregate certain days such as intervention vs. control days or weekdays vs. weekend days). Chrononutrition behaviors based on continuous measures of time (i.e., eating window evening latency, evening eating) are simply averaged. CP-D chrononutrition behaviors based on weekly frequency (i.e., breakfast skipping, night eating) are converted to percentage of days present. The aggregate largest meal variable on the CP-D is represented by the mode across all days of CP-D collection.

The aggregate continuous CP values are then categorized into one of 3 "chrononutrition behavior cutoffs" for each chrononutrition behavior (0=good, 1=fair, and 2=poor). Specific cutoff values for each chrononutrition categorization were based on current empirical evidence and are displayed in Table 1. Additional modification is required of CP-D aggregate variables to fit the chrononutrition behavior cutoffs described in Table 1. Chrononutrition behavior cutoff scores based on weekly frequencies (i.e., breakfast skipping and night eating) are categorized based on the percentage of days used as cut-offs in the CP scoring. For example, skipping

breakfast four or more days per week (i.e., 57%) is categorized as poor chrononutrition. So, an individual who reports skipping breakfast 2 out of 3 (i.e., 67%) days on the CP-D would be categorized as having poor chrononutrition because their score is greater than 57%.

Table 1

Chrononutrition behavior descriptions and scoring cutoffs for the Chrononutrition Profile

Chrononutrition Cutoff	Description	Format	Scoring Cutoffs (Poor; Fair; Good)
Eating Window	Duration between first eating event and last eating event	HH:MM	> 14:00 12:01 to 14:00 ≤12:00
Breakfast Skipping	Frequency of breakfast skipping	Days/Week	≥ 4 days/week 2-3 days/week 1 day/week or less
Evening Latency	Duration between last eating event and sleep onset	HH:MM	≤2:00 2:01 to 6:00 >6:00
Evening Eating	Risk of eating late in the waking day	HH:MM	≥23:00 20:00 to 22:59 < 20:00
Night Eating	Frequency of night eating	Days/Week	≥ 4 days/week 2-3 days/week 1 day/week or less
Largest Meal	Meal in which largest amount of food is eaten	Meal Name	Dinner/Supper Lunch Breakfast

Note. Diary data should be averaged across data collection period. Questionnaire data should be weighted for weekdays and weekends.

Note. Poor values assigned a score of 2; fair values assigned a score of 1; good values assigned a score of 0.

Note. When calculating risk for breakfast skipping and night eating frequency as reported in the diary, we recommend calculating the proportion of days missed. ≥57% should be coded as 2, 28.5% to 42.8% should be coded as 1, and ≤14.2% should be coded as 0.

Finally, the 6 chrononutrition behavior cutoff scores are summed to compute a total CP score which represents one's chrononutrition profile. Possible scores range from 0 to 12 with 0 indicating good chrononutrition status and 12 indicating poor chrononutrition status.

Though the continuous values and total scores represent the primary measures of the CP, additional items were included to provide further options for data collection and analysis. For example, one can additionally calculate the time between eating events, the nighttime fasting period, eating midpoint, total sleep time, and sleep midpoint. The CP-Q includes questions about chrononutrition preferences, which allows for estimation of discrepancy between preferred and actual chrononutrition patterns as measured by the CP-Q or CP-D. Preference items in the CP-Q are modeled after those in the Composite Scale of Morningness (CSM; Smith, Reilly, & Midkiff, 1989). Moreover, the CP allows one to calculate desynchrony between weekday and weekend values, and the CP-D can be used to examine day-to-day variability in chrononutrition.

Present Study

The following paragraphs describe participant recruitment, study procedures, and analyses to allow for examination of the reliability and validity of the CP.

Participants

Power analyses were conducted to determine appropriate sample size. Sample size recommendations were conducted for each proposed analysis. Estimates for hierarchical regression yielded the largest total sample size, which thus served as the guideline for the present study's sample size. A sample size of at least 130 is required to detect a small effect size (0.1) at alpha of .05, power of .9 (Faul, Erdfelder, Buchner, & Lang, 2009).

192 participants completed Part 1 of the study, 150 individuals completed Part 2, and 147 individuals completed Part 3. Attrition analyses indicated that, compared to individuals who

completed only Part 1 or Part 2, individuals who completed the entire study did not differ in terms of age, gender, race, or class rank. Only participants who had completed the entire study were included in the present analyses, as this study was conducted for measure validation purposes.

All participants (N=147) were undergraduate students enrolled in psychology courses at North Dakota State University. Study enrollment occurred online through Sona Systems, a form of participant management software maintained by the university's psychology department. Individuals were eligible to enroll in the study if they were at least 18 years old. Participants were required to have home Internet access through a phone, computer, or tablet to complete the study.

Participants were primarily Caucasian (82.6), female (80.14%), and in their freshman year (63.01%), all of which are consistent with the demographic profile of undergraduate students in the North Dakota State University psychology department. Participants' ages ranged from 18 to 31 years (M = 19.3, SD = 1.7). See Table 2 for detailed demographic information on participants.

Table 2

Sample demographics

Demographic Variable	Parameter
Age	
Mean	19.33
SD	1.70
Class Rank	
Freshman	92 (63.01%)
Sophomore	33 (22.60%)
Junior	14 (9.59%)
Senior	7 (4.79%)
Gender	
Male	29 (19.86%)
Female	117 (80.14%)
Race	
Asian	7 (4.79%)
African American	9 (6.16%)
White	123 (84.25%)
Other/Mixed	7 (4.79%)

Note. N = 147.

Participants received course credit for participating in the three phases of the survey study. The consent process and data collection were completed entirely online. For Part 1, after consenting to participate, participants were asked to provide demographic information and complete a series of questionnaires via Sona Systems. These measures included: the CP-Q, the CSM (Smith et al., 1989), the NEQ (Allison et al., 2008), the Rapid Eating Assessment for Patients (REAP; Gans et al., 2003), the 36-item Short Form Health Survey (SF-36; Ware & Sherbourne, 1992), the PSQI (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), the International Physical Activity Questionnaire Short Form (IPAQ-SF; Craig et al., 2003), the Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Belin, 1994), and the Center for Epidemiologic Studies – Depression Scale (CES-D; Radloff, 1977). Participants' BMI was calculated using two items within the EDE-Q which assess height and weight. For Part 2 of the study, all participants completed three days of the CP-D on PsychData Surveys, a secure online

software program designed specifically for psychological survey research. Participants were also asked to complete three subsequent days of the Automated Self-Administrated 24-hour dietary intake assessment (ASA24; Automated self-administered 24-hour recall, 2016). Within 14 to 21 days after their initial completion of the CP-Q, participants were asked to complete the CP-Q a second time for Part 3 of the data collection period. The following additional measures were completed during Part 3: the 10-item Personality Inventory (TIPI; Gosling, Rentfrow, & Swann Jr., 2003), the 10-item Perceived Stress Scale (PSS10; Cohen, Kamarck, & Mermelstein, 1983), and the State-Trait Anxiety Inventory (STAI; Speilberger, 1983). Data collected from measures administered throughout the three study phases will be invaluable in determining validity and reliability of both the CP-Q and CP-D.

Measures

Demographic information. Participants were asked to report basic demographic information (e.g. gender, age, race, class rank). As described previously, participants were also asked about demographic factors which may contribute to their health and behavior (e.g. shift work, medical conditions, medications) to allow for assessment of potential covariates, as research has not yet indicated whether one's chrononutrition profile varies based on demographic characteristics.

Convergent validity measures. As no global, validated measure of chrononutrition was available at the time of CP development, specific items in the ASA24 (Automated self-administered 24-hour recall, 2016), the PSQI (Buysse et al., 1989), and the NEQ (Allison et al., 2008) were used to examine convergent validity for key continuous variables assessed by the CP. Table 3 displays the items in each measure which were used to assess convergent validity.

Table 3

Convergent validity of the Chrononutrition Profile

Risk Indicator	Estimate of Validity
Eating Window	Times of first and last reported eating event (ASA24)
Breakfast Skipping	Proportion of times breakfast was not reported (ASA24)
Evening Latency	Bedtime, sleep onset latency (PSQI) and last reported eating event (ASA24)
Evening Eating	Time of last reported eating event (ASA24)
Night Eating	Total score (NEQ)
Largest Meal	Calorie intake of all meals for the day (ASA24)

Note. ASA24=Automated Self-Administered 24-hour Dietary Assessment Tool; PSQI=Pittsburgh Sleep Quality Index; NEQ= Night Eating Questionnaire.
Note. Validity calculations using the ASA24 involve comparisons to weighted aggregate value for the questionnaire and day-to-day matching for the diary.

ASA24. The ASA24 Dietary Assessment Tool, developed by the National Cancer Institute, Bethesda, MD, enables researchers to collect Web-based 24-hour dietary recalls (Automated self-administered 24-hour recall, 2016). The ASA24 is modeled after the interviewer-administered Automated Multiple-Pass Method and is a valid and feasible tool for collecting dietary intake data in large samples of both English and Spanish speakers (Kirkpatrick et al., 2014). Participants report dietary intake factors such as the location and timing of food intake, portion size, and preparation of food (Automated self-administered 24-hour recall, 2016; Subar et al., 2012). The assessment asks participants to report the time of their food intake but does not examine sleep onset/offset relative to meals and snacks, preferences for the timing of food intake, or barriers impacting the timing of eating.

PSQI. The PSQI (Buysse et al., 1989) is a self-report assessment of sleep quality over the past month. Participants are asked to report information such as their bed time and wake time,

how many minutes it takes them to fall asleep, and their subjective sleep quality. Responses to these are used to compute seven PSQI component scores (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction). Possible component score values range from 0 (no difficulty) to 3 (severe difficulty). Component scores are then totaled to create a global score, ranging from 0 to 21. A PSQI global score of "0" indicates no difficulty while a score of "21" indicates severe difficulty in each of the seven components of sleep quality. The PSQI has demonstrated reliability and validity in diverse samples (Carpenter & Andrykowski, 1998; Gelaye et al., 2014; Hinz et al., 2017).

NEQ. The *NEQ* contains 14 items and is used to assess severity of night eating symptomatology through 4 factors, including "nocturnal ingestions, evening hyperphagia, morning anorexia, and mood/sleep" (Allison et al., 2008, p. 62). Example items include: "Do you need to eat in order to get back to sleep when you awake at night?", "How much of your food intake do you consume *after* suppertime?" and "How much control do you have over your eating while you are up at night?". Items are scored from 0 to 4, with 0 indicating low severity and 4 indicating extreme severity. 13 of the 14 items are summed to compute a total score; therefore, total scores may range from 0 to 52. Good psychometric properties of this measure have been demonstrated (Allison et al., 2008; Latzer, Tzischinsky, Rozenstein, & Allison, 2014; Harb, Caumo, & Hidalgo, 2008; Moizé et al., 2012).

Concurrent validity measures. As chrononutrition and circadian misalignment have been associated with negative mental and physical health outcomes (namely, weight gain and obesity), concurrent validity of the CP-Q was determined by computing participants' chrononutrition cutoff score (i.e., good; fair; poor) and then comparing these with measures of

quality of life. Concurrent validity will be supported if the chrononutrition behavior cutoff score is predictive of self-reported BMI data and SF-36 general health scores (Ware & Sherbourne, 1992), above and beyond the REAP, an established measure of dietary intake. We hypothesized that a worse chrononutrition cutoff score would be predictive of higher BMI and lower general health.

REAP. The REAP (Gans et al., 2006) is comprised of 31 items which assess the frequency of various unhealthy and healthy dietary intake patterns and behaviors in a typical week (e.g. "In an average week, how often do you add butter, margarine or oil to bread, potatoes, rice or vegetables at the table?"; "In an average week, how often do you add salt to foods during cooking or at the table?"). Three items which assess food shopping and cooking and willingness to change one's diet were excluded from the REAP for the current study, as these were beyond the scope of this study. Items are summed, with higher REAP scores reflecting a healthier diet. The REAP is a validated and reliable dietary assessment method (Gans et al., 2006). Cronbach's alpha was good in the present study (α =.80).

SF-36. The SF-36 evaluates eight health concepts which are indicative of quality of life and wellbeing; these include: physical functioning, vitality, mental health, bodily pain, physical role functioning, emotional role functioning, social role functioning, and general health perceptions (Ware & Sherbourne, 1992). Example items include "How much bodily pain have you had during the past 4 weeks" and "During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relative, etc.)?". Response options are given in a Likert-type scale, with each item containing two to six response options. The SF-36 has been widely-used as a health evaluation tool; extensive evidence has indicated the reliability and validity of this measure (Brazier et al.,

1992; Jenkinson, Wright, & Coulter, 1994; Zhang, Qu, Lun, Guo, & Liu, 2012). Cronbach's alpha for the general health subscale was acceptable in the present study (α =.72).

EDE-Q. This measure, derived from the Eating Disorder Examination interview, consists of 33 questions which are designed to assess eating disorder symptomatology (Fairburn & Beglin, 1994). Specifically, the measure contains four subscales to assess cognitions related to eating disorders: restraint, eating concern, shape concern, and weight concern. The EDE-Q also contains items which assess behavioral symptoms of eating disorders (e.g., binge eating, excessive exercise). Participants are asked to report the extent to which they experience cognitions or engage in behaviors which are indicative of eating disorder symptomatology. Higher scores indicate greater symptomatology. This assessment has been shown to be valid and reliable (for review, see Berg, Peterson, Frazier, & Crow, 2012). In the present study, two items from the EDE-Q which assess height and weight were utilized to calculate BMI.

Additional covariates and correlates for future inquiry. Various avenues of research have yet to be explored with the concept of chrononutrition. Inclusion of the following measures will allow for exploratory examination of relationships between an individual's chrononutrition profile, an individual's preference for the timing of eating, and factors such as perceived stress, diet composition, and chronotype.

PSS10. The PSS consists of four, 10, or 14 items which assess the extent to which individuals appraise life events over the past month as stressful (Cohen et al., 1983). Example items include: "In the last month, how often have you felt that things were going your way?" and "In the last month, how often have you found that you could not cope with all the things that you had to do?". Possible responses range from 0 *(never)* to 4 *(very often).* Responses to four positively-worded items are reverse-scored; all responses are then summed to calculate a total

score. The 10-item version of the PSS (PSS10) has been shown to be more psychometrically sound than the 14-item and four-item versions (Lee, 2012), so the PSS10 will be utilized in the present study to examine concurrent validity. The PSS10 has been validated for use in diverse samples (Remor, 2006; Roberti, Harrington, & Storch, 2006; Wu and Amtmann, 2013).

Because adverse chrononutrition patterns have been associated with abnormal cortisol rhythms, perhaps unhealthy eating times could be related to increased perceived stress. Individuals may consume foods at abnormal times in order to cope with perceived stressors (e.g. to meet a deadline with work or school), or they may perceive their eating patterns as unhealthy and thus feel stress. Additionally, because prior research suggests that food intake may alter patterns in diurnal cortisol release throughout the day (Schoeller, Cella, Sinha, & Caro, 1997), individuals with greater perceived stress (i.e. abnormal cortisol release rhythms) may also report a lack of appetite at the typical breakfast time, which could further misalign their eating throughout the day. Eating outside of one's preferred time may also contribute to greater perceived stress, though this has not been examined to date.

Caloric intake. Though self-reported dietary intake tools such as the ASA24 are prone to misreporting biases in terms of total energy intake (Archer, Hand, & Blair, 2013), information gathered on caloric intake may be valuable to interpret temporal patterns of food intake throughout the day.

Previous research has suggested that factors such as poor sleep may impact diet quality, as individuals may choose energy-dense foods to compensate for lack of sleep (Chaput, 2014); research has also indicated that morning-type individuals may make unhealthier dietary choices (Kanerva et al., 2012). However, research has not yet determined whether an adverse chrononutrition pattern may occur independently of an unhealthy diet or if the two co-occur.

Because the CP-Q and CP-D were designed to supplement existing dietary assessments, knowledge provided by the REAP and caloric intake information provided by the ASA24 could inform the role of chrononutrition in diet composition research.

TIPI. As described above, prior literature has suggested an association between personality traits and chronotype, though not much evidence exists surrounding the association between personality traits and chrononutrition. Therefore, the TIPI, a 10-item assessment of the Big Five personality domains, will be used to examine this relationship in future analyses (Gosling et al., 2003). Participants are asked to indicate how strongly they agree or disagree with each of the ten items, on a 7-point Likert scale, from 1 (*disagree strongly*) to 7 (*agree strongly*). Sample items include: "I see myself as extraverted, enthusiastic" and "I see myself as sympathetic, warm". The ten items are paired to reflect opposing aspects of each of the Big Five personality traits (e.g. the scale covers both introversion and extraversion), and one of the items in the pair is reverse-scored. The two paired items are then averaged to generate a subscale of each of the Big Five personality traits. Evidence suggests that the TIPI, although brief, is a valid and reliable measure of personality traits (Erhart et al., 2009; Gosling et al., 2003; Romero, Villar, Gómez-Fraguela, & López-Romero, 2012).

CSM. The CSM is designed to assess chronotype, or sleep-wake timing preference. 9 items from the Morningness-Eveningness Questionnaire (Horne & Ostberg, 1976) and 4 items from the Diurnal Type Scale (Torsvall & Akerstedt, 1980) comprise the CSM (Smith et al., 1989). Every item of the CSM has either 4 or 5 possible response options, with values assigned to each response option ranging from 1 (representing extreme eveningness) to 4 or 5 (representing extreme morningngess). Values for all items are summed to produce a total score. Possible total scores range from 13 to 55, with higher scores reflecting a morning chronotype.

Evidence of reliability and validity of the CSM has been demonstrated, and the CSM has been shown to improve upon the scales on which it is based (Smith et al., 1989; Guthrie, Ash, & Bendapudi, 1995; Natale & Alzani, 2001).

Though chronotype varies slightly with age (Roenneberg et al., 2007), it appears to be a relatively stable phenomenon (Paine et al., 2006). However, research has not yet indicated whether chrononutrition patterns are also stable over time. An individual's circadian rhythm, and thus, chrononutrition profile, could hypothetically fluctuate based on the presence of highly variable environmental Zeitgebers (e.g. food availability, light exposure). Therefore, chronotype could be examined along with individuals' average CP-D values to determine whether chrononutrition is susceptible to day-to-day variability or if chrononutrition patterns remain quite similar over time. Chronotype may also be examined in relation to preference items on the CP-Q to examine whether morning type individuals also prefer to eat earlier in the day and evening type individuals prefer to eat later in the day.

STAI. This widely-used measure consists of 40 items used to assess anxiety (Speilberger, 1983). Because the measure is used to distinguish between transient "state anxiety" and generalized "trait anxiety", two subscales are produced. The state anxiety subscale consists of 20 items for which participants rate how anxious they currently feel (e.g. "I feel upset"; "I feel nervous"), while participants indicate the frequency with which they generally feel anxious (e.g. "I lack self-confidence"; "I feel like a failure") for the trait anxiety subscale. Response options range from 1 to 4, with higher scores representing greater state or trait anxiety. Total scores for each subscale range from 20 to 80. This assessment tool has been validated and is a reliable measure of anxiety in a wide array of samples (Speilberger & Vagg, 1984).

IPAQ- SF. The short form IPAQ consists of 7 items which ask participants to estimate the amount of time they spent sitting, walking, and engaging in moderate- and vigorous-intensity physical activities, over the last 7 days (Craig et al., 2003). Items include: "During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?" and "During the last 7 days, how much time did you spend sitting on a week day?". The measure was designed for adults aged 18-65. The measure has shown evidence of reliability and validity (Craig et al., 2003).

CES-D. The CES-D is designed to measure the severity of depressive symptoms in the general population (Radloff, 1977). This measure consists of 20 items which ask participants to report the extent to which they experience symptoms of depression. Example items include: "My sleep was restless" and "I felt that everything I did was an effort". Possible response options for each item are: 0 (*rarely or none of the time*), 1 (*some or a little of the time*), 2 (*occasionally or a moderate amount of time*), and 3 (*most or all of the time*). Scores on the CES-D range from 0 to 60, with higher scores indicating greater depressive symptomatology. This assessment method has demonstrated good psychometric properties in diverse samples of participants (Chin, Choi, Chan, & Wong, 2015; Hunter et al., 2003a; Hunter et al., 2003b; Knight, Williams, McGee, & Olaman, 1997).

Demographic variables. Examination of demographic variables would allow for determination of potential covariates associated with adverse chrononutrition profiles, as this has not yet been examined in the literature. For example, men could be more likely to consume food late at night, and shift work would likely affect chrononutrition patterns. Perhaps chrononutrition patterns and/or preference would also differ according to class rank or age.

Data Analysis

Goals for the present analyses included: a) exploring the characteristics of individual items and b) evaluating validity and reliability of the CP.

To test convergent validity of the CP-Q, Pearson product-moment coefficients were calculated between continuous weighted CP-Q values and select items from the averaged ASA-24 data and the PSQI (criteria summarized in Table 3).

Linear mixed models were used to compare continuous day-to-day values reported in the CP-D with continuous values reported in the ASA24, as correlating repeated measures is a violation of the assumption of independence. Chi-square analyses were used to compare the dichotomous value of breakfast consumption from the CP-D to the dichotomous value from the ASA24.

Concurrent validity of the CP-Q and CP-D was estimated through hierarchical linear regression. Participants' REAP scores were entered in step 1 of the model, while the chrononutrition total scores were entered in step 2. We hypothesized that higher CP total scores would be associated with higher BMI and lower quality of life, above and beyond what was predicted by the REAP.

Test-retest reliability of the CP-Q was examined using bivariate correlations (Pearson's *r*) to determine whether continuous values on the CP-Q are stable over a two- to three-week time frame. Chi-square analyses were conducted to examine agreement between categorical values on the CP-Q (e.g., largest meal) over the two- to three-week period. Additional estimates of internal consistency were not calculated because the measure represents more of a risk checklist than a composite scale.

For the convergent validity and test-retest reliability tests proposed, an absolute Pearson's *r* value of .8 or greater would indicate good reliability and validity and provide support for the utility of the measure. Pearson's *r* scores below an absolute value of .8 may indicate a need for further exploration and measure refinement. For concurrent validity, a significant change in R^2 would suggest that the CP-Q predicts BMI and wellbeing above and beyond the REAP, an existing measure of dietary intake.

RESULTS

Statistical analyses were conducted to examine the characteristics of the CP, and to evaluate concurrent validity, convergent validity, and test-retest reliability.

Exploring and Preparing the CP for Analyses

Descriptive statistics were used to explore characteristics of the CP. More specifically, we examined the range and distribution of scores on individual items, chrononutrition behavior cutoff classifications, and total scores to identify any floor or ceiling effects or other unexpected distribution patterns. Night eating was reported at a low frequency in this sample. 10 participants (6.8%) self-reported waking in the night to eat on at least 1 night per week in the CP-Q, but only 2 participants (1.4%) actually reported waking in the night to eat in the CP-D. Further, 0 participants were classified as night eaters based on their NEQ scores. Because of this low base rate, night eating was not included in the present analyses.

Our original analysis plan included testing the convergent validity of the largest meal. To do this, caloric intake of each eating event reported within the ASA24 was first explored to determine the eating event in which the greatest number of calories was consumed. We then computed a proportion of days for which each eating event was the largest meal (i.e., greatest caloric intake), out of all days of data collection. If participants reported the same largest meal on more than half of days (i.e., more than 50%), this was considered their typical largest meal. If participants did not report the same largest meal on more than 50% of days, they were considered to not have a typical largest meal. Participants' typical largest meal, as reported in the ASA24, was then compared to their largest meal as reported in the CP-Q to determine the level of agreement between these variables. However, comparisons of participants' reported largest meal between the CP-Q and the ASA24 indicated that only 31.20% of participants matched in

their reporting of the typical largest meal. A Chi-square test assessing agreement between the largest meal as reported in the CP-D and the largest meal as reported in the ASA24 showed a significant relationship (χ^2 (9, N = 458) = 57.61, p<.001); however, participant responses matched on only 208 intervals (41.43%). Because there was such little agreement between the ASA24 and the CP, this suggests that responses to this item were not accurate, and this item was removed from the CP-Q and the CP-D and excluded from other stages of analysis.

Data from all study materials were explored for normality and basic statistical assumptions. Means, standard deviations, ranges, skewness, and kurtosis were computed for CP items and variables used to evaluate validity and reliability (see Tables 4 - 9). Preferred morning latency, as assessed in the CP-Q during Part 1 had a slight positive skew (2.31), was leptokurtic (6.88), and was not normally distributed. Data were also examined to assess for impossible values (e.g., reporting last eating event after bedtime; reporting first eating event prior to wake time). Some evidence of random participant error was discovered. In the CP-D, 5 participants reported bedtime prior to their last eating event on a total of 5 intervals (1.07%); these intervals were excluded from analyses involving the last eating event. In addition, we evaluated the presence of missing data for each individual item, which could indicate items that were uncomfortable, difficult to answer, or difficult to understand. However, overall, results indicated that data were normally distributed, skewness and kurtosis were within acceptable ranges, a broad range of values were reported, and only a few instances of impossible values were reported.

Table 4

Descriptive statistics of calculated chrononutrition behaviors and ASA24 variables

Chrononutrition Behavior	Range	Mean	SD	Skewness	Kurtosis
CP-Q					
Breakfast Skipping	0.00 – 100.00	41.77	0.34	0.31	-1.21
Evening Eating	15:00 – 2:00	19:56	1:46	0.28	0.42
Evening Latency	30.00 - 450.00	229.91	97.21	0.12	-0.49
Eating Window	300.00 - 915.00	590.91	138.48	0.05	-0.48
ASA24					
Breakfast Skipping	0.00 – 100.00	37.86	0.41	0.47	-1.40
Evening Eating	12:12 – 24:00	19:39	1:46	-0.71	1.45
Evening Latency	30.00 – 780.00	290.52	123.08	0.71	1.02
Eating Window	195.00-899.00	560.89	135.33	0.01	-0.22
CP-D					
Breakfast Skipping	0.00 – 100.00	38.19	0.40	0.44	-1.37
Evening Eating	11:00 – 2:35	19:50	2:17	-0.32	1.48
Evening Latency	0.00 - 840.00	281.01	148.09	0.83	1.21
Eating Window	0.00 - 1020.00	532.56	203.59	-0.63	0.66
ASA24					
Breakfast Skipping	0.00 – 100.00	37.90	0.39	0.45	-1.32
Evening Eating	11:00 – 24:00	19:42	2:08	-0.69	1.61
Evening Latency	0.00 – 965.00	284.16	143.82	0.839	1.42
Eating Window	60.00 – 1005.00	565.78	166.97	-0.18	-0.45

Note. CP-Q = Chrononutrition Profile – Questionnaire; ASA24 = Automated Self-Administered 24-hour Dietary Assessment Tool; CP-D = Chrononutrition Profile – Diary.
Note. Breakfast skipping represented as percent of days per week, evening eating represented as HH:MM, evening latency and eating window represented as minutes.

Table 5

Descriptive statistics of Chrononutrition Profile-Questionnaire items from part 1

CP-Q Item	Range	Mean	SD	Skewness	Kurtosis
Wake Time - WKND	5:00 – 13:00	9:53	1:17	-0.56	0.64
Wake Time - WKDY	4:20 – 11:00	8:05	1:07	-0.51	0.61
Wake Time - PREF	5:00 – 13:00	9:22	1:11	-0.43	1.50
First Eating Event - WKND	7:15 – 16:00	11:13	1:28	-0.11	0.23
First Eating Event - WKDY	4:45 – 18:00	10:05	1:57	0.53	1.35
Morning Latency - PREF	**10.00 – 270.00**	**59.52**	**43.42**	**2.31**	**6.88**
Lunchtime - WKND	11:00 – 17:00	12:56	1:04	0.80	0.71
Lunchtime - WKDY	11:00 – 16:00	12:34	0:58	0.67	0.58
Last Eating Event - WKND	17:00 – 2:00	20:46	1:55	0.29	-0.46
Last Eating Event - WKDY	17:00 – 2:00	19:59	1:46	0.44	0.03
Evening Latency - PREF	10.00 – 300.00	138.46	68.75	0.39	-0.38
Bedtime - WKND	21:00 – 3:00	24:45	1:14	-0.10	-0.11
Bedtime - WKDY	21:00 – 3:00	23:46	1:06	0.13	0.11
Bedtime - PREF	21:00 – 3.00	23:14	1:05	1.08	1.97
Breakfast Consumption (Days/Week)	0.00 – 7.00	4.08	2.41	-0.31	-1.21
CP-Q Total Score	0.00 – 8.00	2.95	1.43	.69	.78

Note. CP-Q = Chrononutrition Profile – Questionnaire; WKND = weekend; WKDY = weekday; PREF = preference.
Note. Bolded rows indicate items with skewness and kurtosis.

Table 6

Descriptive statistics of Chrononutrition Profile - Questionnaire items from part 3

CP-Q Item	Range	Mean	SD	Skewness	Kurtosis
Wake Time - WKND	6:00 – 13:00	9:53	1:22	-0.38	-0.33
Wake Time - WKDY	4:15 – 11:00	8:10	1:09	-0.19	0.66
Wake Time - PREF	5:00 – 13:00	9:23	1:11	-0.37	1.15
First Eating Event - WKND	7:30 – 14:00	11:11	1:31	-0.38	-0.43
First Eating Event - WKDY	4:45 – 15:00	10:03	1:52	0.05	-0.10
Morning Latency - PREF	0.00 – 180.00	56.78	36.74	1.55	2.55
Lunchtime - WKND	11:00 – 16:00	12:59	1:07	0.34	-0.61
Lunchtime - WDKY	11:00 – 16:00	12:32	0:57	0.52	0.25
Last Eating Event - WKND	16:30 – 2:00	20:37	1:52	0.45	0.13
Last Eating Event - WKDY	16:00 – 1:00	19:56	1:42	0.41	-0.17
Evening Latency - PrREF	10.00 – 360.00	142.64	72.84	0.58	-0.19
Bedtime - WKND	21:30 – 27:00	24:39	1:13	-0.12	-0.36
Bedtime - WKDY	21:00 – 26:30	23:48	1:07	0.10	-0.19
Bed Time - PREF	21:00 – 3:00	23:15	1:00	0.73	1.19
Breakfast Consumption (Days/Week)	0.00 – 7.00	4.06	2.30	-0.22	-1.23

Note. CP-Q = Chrononutrition Profile – Questionnaire; WKND = weekend; WKDY = weekday; PREF = preference.

Table 7

Descriptive statistics from the Chrononutrition Profile- Diary

CP-D Item	Range	Mean	SD	Skewness	Kurtosis
Wake Time	4:15 – 13:00	8:35	1:32	-0.03	-.13
First Eating Event	4:45 – 21:00	10:54	2:42	0.90	1.73
Last Eating Event	14:00 – 24:22	19:48	1:45	-0.05	0.58
Bedtime	20:45 – 6:30	24:24	1:33	0.51	0.76
Breakfast Skipping Frequency (% of Days)	0.00 – 100.00	38.81	.49	0.46	-1.80
CP-D Total Score	0.00 – 6.00	2.33	1.33	.44	.02

Note. CP-D = Chrononutrition Profile – Diary.

Table 8

Distribution of chrononutrition behavior cutoffs for Chrononutrition Profile

CP-Q		CP-D	
Eating Window	N	Eating Window	N
Good (12:00 or less)	116	Good (12:00 or less)	75
Fair (12:01 to 14:00)	22	Fair (12:01 to 14:00)	5
Poor (> 14:00)	5	Poor (> 14:00)	1
Evening Eating	N	Evening Eating	N
Good (<20:00)	68	Good (<20:00)	45
Fair (20:00 to 22:59)	71	Fair (20:00 to 22:59)	39
Poor (23:00 or later)	6	Poor (23:00 or later)	2
Evening Latency	N	Evening Latency	N
Good (>6:00)	13	Good (>6:00)	13
Fair (2:01 to 6:00)	103	Fair (2:01 to 6:00)	64
Poor (≤2:00)	28	Poor (≤2:00)	4
Breakfast Skipping	N	Breakfast Skipping	N
Good (1 or fewer days/week)	51	Good (1 or fewer days/week)	40
Fair (2 to 3 days/week)	36	Fair (2 to 3 days/week)	11
Poor (4 or more days/week)	57	Poor (4 or more days/week)	29

Note. CP-Q = Chrononutrition Profile – Questionnaire. CP-D = Chrononutrition Profile – Diary.

Table 9

Descriptive statistics from measures used to evaluate validity and reliability of Chrononutrition Profile

	Range	Mean	SD	Skewness	Kurtosis
BMI	17.58 – 45.80	24.05	4.47	1.96	5.45
SF-36 General Health	10.00 – 100.00	66.70	18.72	-0.46	-0.25
PSQI Bedtime	20:00 – 27:00	23:48	1:09	-0.21	0.58
PSQI Wake Time	4:20 – 11:00	8:16	1:08	-0.55	0.61
ASA24 Items					
First Eating Event	4:30 – 20:50	10:24	2:22	0.67	1.34
Last Eating Event	11:00 – 24:00	19:42	2:08	-0.69	1.61
Breakfast Skipping Frequency (Percent of Days)	0.00 – 100.00	37.90	0.49	0.50	-1.76

Note. BMI = body mass index; SF-36=Medical Outcomes Study 36-item Short Form Health Questionnaire; PSQI = Pittsburgh Sleep Quality Index; ASA24 = Automated Self-Administered 24-hour Dietary Assessment Tool

The CP-D had extremely low rates of missing data with only three participants missing one item each. Wake time was not reported by two participants, and the time of a snack or drink eaten after the last meal of the day was not reported by one participant. The CP-Q also had very low rates of missing data, with a total of 7 participants missing data. There were three missing values for Part 1 and four missing values for Part 3. Missing values in Part 1 were for items asking about participants' first eating event on weekend days, last eating event on weekdays, and frequency of breakfast consumption. Missing values in Part 3 were for items asking about participants' wake time on weekend days, frequency of nighttime snack consumption, breakfast consumption frequency, and bedtime preference. The very low rates of missingness distributed across a range of items do not identify any problematic items.

Prior to analyses in which ASA24 values were compared to CP-Q values, ASA24 intervals in which participants reported being ill were excluded. This was done because the CP-Q is designed to assess one's general chrononutrition on a typical day, and illness would indicate that a given interval was not normal. Of the 467 intervals collected via the ASA24, 35 intervals were excluded from CP-Q calculations and analyses due to participant illness.

Because of differences in the timing of assessment of the ASA24, 3 different methods were used to compare values to the CP-Q. If participants only reported weekend days on the ASA24 (N=5), we only used weekend values that were reported in the CP-Q. If participants reported only weekday values on the ASA24 (N=71), we used only weekday values that were reported in the CP-Q. Finally, if participants reported both weekend days and weekdays in the ASA24 (N=71) we computed a weighted weekly average CP-Q value as previously described which included both weekend and weekday CP-Q values. These steps were taken to ensure that

the type of day matched in each assessment, but would not be necessary for protocols using the published CP-Q.

Convergent Validity

Pearson's product-moment correlations between CP-Q and ASA24 assessed behaviors (i.e. evening latency, evening eating, breakfast skipping, and eating window) ranged between 0.28 to 0.58 (all *p*'s <.01), indicating a moderate to strong association. In addition, CP-Q bedtime and wake time were very strongly correlated with PSQI bedtime and wake time (r = .90 for both). Results from convergent validity analyses using the CP-Q are shown in Table 10, with correlation coefficients of corresponding values bolded.

Linear mixed model analyses using CP-D variables indicated that the first eating event, last eating event, eating window, and evening latency variables were significant predictors of their corresponding ASA24 variables (all *p*'s < .001); see Tables 11 - 14 for results of each analysis. Further, R-squared calculations showed that there was overlap in variance explained between the CP-D variables and the ASA24 variables, with R-squared values ranging from 5.0% overlap (last eating event) to 25.0% overlap (first eating event) between the two measures. The Chi-square analysis comparing breakfast consumption in the CP-D to breakfast consumption in the ASA24 showed significant agreement (χ^2 (1, N = 467) = 269.57, p<.001) with participant responses matching on 442 intervals out of 502 total intervals.

Table 10

Bivariate correlations for convergent validity estimates

	ASA24 Evening Latency	CP-Q Evening Latency	ASA24 Evening Eating	CP-Q Evening Eating	ASA24 Breakfast Skipping Frequency	CP-Q Breakfast Skipping Frequency	ASA24 Eating Window	CP-Q Eating Window	PSQI Wake Time	CP-Q Wake Time	PSQI Bedtime	CP-Q Bedtime
ASA24 Evening Latency	1	-	-	-	-	-	-	-	-	-	-	-
CP-Q Evening Latency	**.28****	1	-	-	-	-	-	-	-	-	-	-
ASA24 Evening Eating	-.72**	-.14	1	-	-	-	-	-	-	-	-	-
CP-Q Evening Eating	-.09	-.65**	**.29****	1	-	-	-	-	-	-	-	-
ASA24 Breakfast Skipping Frequency	.12	.18*	-.05	-.09	1	-	-	-	-	-	-	-
CP-Q Breakfast Skipping Frequency	.18*	.13	-.04	-.00	**.58****	1	-	-	-	-	-	-
ASA24 Eating Window	-.58**	-.31**	.55**	.15	-.53**	-.39**	1	-	-	-	-	-
CP-Q Eating Window	-.23**	-.69**	.19*	.55**	-.39**	-.54**	**.44****	1	-	-	-	-
PSQI Wake Time	.03	-.03	.22**	.32**	.14	.26**	-.25**	-.14	1	-	-	-
CP-Q Wake Time	.02	-.00	.23**	.27**	.20*	.29**	-.24**	-.18*	**.90****	1	-	-
PSQI Bedtime	.23**	.19*	.20*	.29**	.13	.28**	-.09	-.02	.47**	.46**	1	-
CP-Q Bedtime	.24**	.21*	.22*	.30**	.20*	.28**	-.11	.01	.45**	.47**	**.90****	1

Note. ASA24: Automated Self-Administered 24-Hour Dietary Assessment Tool; CP-Q: Chrononutrition Profile – Questionnaire; PSQI: Pittsburgh Sleep Quality Index

Note. *. significant at the .05 level (2-tailed).

Note. **. significant at the .01 level (2-tailed).

Note. Bolded correlation coefficients represent comparisons between corresponding items on ASA24, CP-Q, and PSQI.

Table 11

Linear mixed model analyses comparing first eating event from Chrononutrition Profile - Diary with first eating event from ASA24

	Model 1				Model 2			
	Estimate	SE	CI	p	Estimate	SE	CI	p
Fixed Effects								
Intercept	602.29	10.40	581.83 – 622.75	<.001	248.27	22.05	204.93 – 291.61	<.001
Time	22.88	6.43	10.21 – 35.55	<.001	21.81	5.54	10.27 – 32.09	<.001
First Eating Event					0.55	0.04	0.48 - 0.62	<.001
Random Effects								
Repeated Measures Variance	12776.25	1040.91	10890.66 – 14988.31	<.001	9550.52	787.40	8125.49 – 11225.48	<.001
Intercept Variance	7054.38	1348.10	4850.58 – 10259.46	<.001	1934.58	674.95	976.37 – 3833.17	.004
R-Squared	.25							

Note. CI = confidence interval; SE = standard error; ASA24 = Automated Self-Administered 24-Hour Dietary Assessment Tool.
Note. Model 1 = unconditional model with ASA24 variable as outcome; Model 2 = model with CPD variable as predictor and ASA24 variable as outcome.

Table 12

Linear mixed model analyses comparing last eating event from Chrononutrition Profile - Diary with last eating event from ASA24

	Model 1				Model 2			
	Estimate	SE	CI	*p*	Estimate	SE	CI	*p*
Fixed Effects								
Intercept	1177.24	9.44	1158.67 – 1195.81	<.001	730.46	49.79	632.59 – 828.33	<.001
Time	5.06	6.37	-7.48 – 17.61	.428	11.61	6.25	-.69 – 23.91	.064
Last Eating Event					.371	0.04	0.29 – 0.45	<.001
Random Effects								
Repeated Measures Variance	12255.81	1010.78	10426.55 – 14406.00	<.001	11698.87	971.75	9941.23 – 13767.27	<.001
Intercept Variance	4097.84	3469782.94	1012.87	<.001	1774.82	760.67	766.19 – 4111.23	.020
R-Squared	.05							

Note. CI = confidence interval; SE = standard error; ASA24 = Automated Self-Administered 24-Hour Dietary Assessment Tool.
Note. Model 1 = unconditional model with ASA24 variable as outcome; Model 2 = model with CPD variable as predictor and ASA24 variable as outcome.

Table 13

Linear mixed model analyses comparing eating window from Chrononutrition Profile - Diary with eating window from ASA24

	Model 1				Model 2			
	Estimate	SE	CI	p	Estimate	SE	CI	p
Fixed Effects								
Intercept	579.69	12.41	555.27 – 604.10	<.001	374.05	22.36	330.11 – 417.99	<.001
Time	-14.98	7.82	-30.37 - 0.42	.057	-8.28	7.59	-23.21 – 6.65	.276
Eating Window					0.37	0.04	0.30 – 0.44	<.001
Random Effects								
Repeated Measures Variance	18365.55	1520.89	15614.00 – 21602.00	<.001	17285.81	1458.84	14650.49 – 20395.17	<.001
Intercept Variance	9486.33	1891.03	6418.26 – 14020.99	<.001	4056.75	1325.45	2138.30 – 7696.41	.002
R-Squared	.06							

Note. CI = confidence interval; SE = standard error; ASA24 = Automated Self-Administered 24-Hour Dietary Assessment Tool.
Note. Model 1 = unconditional model with ASA24 variable as outcome; Model 2 = model with CPD variable as predictor and ASA24 variable as outcome.

Table 14

Linear mixed model analyses comparing evening latency from Chrononutrition Profile - Diary with evening latency from ASA24

	Model 1				Model 2			
	Estimate	SE	CI	p	Estimate	SE	CI	p
Fixed Effects								
Intercept	284.41	10.66	263.46 – 305.36	<.001	153.68	13.52	127.11 – 180.26	<.001
Time	-1.67	7.57	-16.56 – 13.23	.826	-12.59	6.82	-26.00 - 0.83	.066
Evening Latency					0.51	0.04	0.43 – 0.59	<.001
Random Effects								
Repeated Measures Variance	17348.37	1422.39	14773.01 – 20372.69	<.001	13946.91	1146.42	11871.63 – 16384.97	<.001
Intercept Variance	3737.72	1200.24	1991.92 – 7013.60	.002	1282.28	798.63	378.30 – 4346.38	.108
R-Squared	.20							

Note. CI = confidence interval; SE = standard error; ASA24 = Automated Self-Administered 24-Hour Dietary Assessment Tool.
Note. Model 1 = unconditional model with ASA24 variable as outcome; Model 2 = model with CPD variable as predictor and ASA24 variable as outcome.

Concurrent Validity

Hierarchical linear regression was performed to evaluate concurrent validity of the CP-Q and the CP-D. To determine whether CP-Q and CP-D total scores predicted both BMI and general health, four separate regressions were conducted. Analyses to assess concurrent validity of the CP-Q in predicting BMI revealed that for step one, REAP total scores did not significantly contribute to the regression model, $F(1,129) = .20$, $p = .65$, $\beta = -.04$. Adding chrononutrition total scores for the CP-Q in step two did not explain any additional variance, $F(2,128) = .95$, $p = .39$, $\beta = -.12$. Analyses to assess the concurrent validity of the CP-Q in predicting general health also revealed that for step one, REAP total scores did not significantly contribute to the regression model, $F(1,130) = .56$, $p = .46$, $\beta = .07$. Again, adding chrononutrition total scores for the CP-Q did not explain any additional variance, $F(2,129) = 1.28$, $p = .28$, $\beta = .13$.

Identical steps were taken to evaluate concurrent validity of the CP-D in predicting BMI and general health. Results showed that REAP total scores did not significantly contribute to the regression model in predicting BMI in step one, $F(1,130) = .19$, $p = .66$, $\beta = -.04$. Additional variance was explained by adding chrononutrition total scores as assessed by the CP-D in step two, $F(2,129) = 3.23$, $p = .04$, $\beta = -.22$. Finally, when entered in step one, REAP total scores did not significantly predict general health, $F(1,131) = .25$, $p = .62$, $\beta = .04$. Adding chrononutrition total scores to the regression model in step two did not account for any additional variance, $F(2,130) = .13$, $p = .88$, $\beta = .01$. Results of hierarchical regression analyses are displayed in Tables 15 through 18.

Table 15

Hierarchical linear regression analysis for Chrononutrition Profile - Questionnaire predicting BMI

Variable	B	SE B	β	p	R	R^2	ΔR^2
Step 1					.04	.00	.00
REAP total score	-.03	.06	-.04	.65			
Step 2				.391	.12	.02	.01
REAP total score	-.06	.06	-.09	.36			
CP-Q total score	-.39	.30	-.12	.20			

Note. REAP= Rapid Eating Assessment for Patients; CP-Q=Chrononutrition Profile – Questionnaire.

Table 16

Hierarchical linear regression analysis for Chrononutrition Profile - Diary predicting BMI

Variable	B	SE B	β	p	R	R^2	ΔR^2
Step 1					.04	.00	.00
REAP total score	-.03	.06	-.04	.66			
Step 2				.04	.22	.05	.05
REAP total score	-.04	.06	-.07	.44			
CP-D total score	-.76	.31	-.22	.01			

Note. REAP= Rapid Eating Assessment for Patients; CP-D=Chrononutrition Profile – Diary.

Table 17

Hierarchical linear regression analysis for Chrononutrition Profile – Questionnaire predicting general health

Variable	B	SE B	β	p	R	R^2	ΔR^2
Step 1					.07	.00	.00
REAP total score	.17	.22	.07	.46			
Step 2				.28	.14	.02	.02
REAP total score	.30	.24	.12	.22			
CP-Q total score	1.67	1.18	.13	.16			

Note. REAP= Rapid Eating Assessment for Patients; CP-Q=Chrononutrition Profile – Questionnaire.

Table 18

Hierarchical linear regression analysis for Chrononutrition Profile – Diary predicting general health

Variable	B	SE B	β	p	R	R^2	ΔR^2
Step 1					.04	.00	.00
REAP total score	.11	.23	.04	.62			
Step 2				.88	.04	.00	.00
REAP total score	.11	.23	.05	.61			
CP-D total score	.09	1.23	.01	.94			

Note. REAP= Rapid Eating Assessment for Patients; CP-D=Chrononutrition Profile – Diary.

Test-Retest Reliability

Bivariate correlations and chi-square tests were calculated to determine test-retest reliability of the CP-Q over a 14- to 21-day period (Table 19). Because continuous values for weekend days and weekdays are the foundation of computed weekly averages and chrononutrition behavior cutoff scores, it is vital to understand the reliability of these continuous items over time. Therefore, separate correlation coefficients were computed for weekend and weekday values for chrononutrition behaviors (e.g., time of first eating event, bedtime). Reported chrononutrition preferences (e.g., wake time preference, preferred evening latency) were also correlated. Correlations for weekend values ranged from r = .42 (lunchtime) to r = .82 (bedtime), while correlations for weekday values ranged from r = .77 (lunchtime) to r = .86 (bedtime). Coefficients for weekend values were a bit lower than coefficients for weekday values. Correlations for preference items ranged from r = .63 (preferred evening latency) to r =.88 (wake time preference). Weekly averages were also computed for evening eating, evening latency, and eating window. Correlation coefficients were r = .51, r = .63, and r = .80, respectively. In addition, breakfast frequency was correlated, r = .88. All correlations were significant at the p = .01 level.

Table 19

Correlation coefficients for test-retest reliability for the Chrononutrition Profile-Questionnaire over 14-21 days

Item	Pearson's *r*
Chrononutrition Preferences	
Wake Time	.88
Morning Latency	.74
Evening Latency	.63
Bedtime	.76
Chrononutrition Behaviors – Weekend Days	
Wake Time	.70
First Eating Event	.77
Lunchtime	.42
Last Eating Event	.71
Bedtime	.82
Chrononutrition Behaviors - Weekdays	
Wake Time	.82
First Eating Event	.85
Last Eating Event	.76
Lunchtime	.77
Bedtime	.86
Computed Weekly Averages	
Breakfast Frequency	.88
Evening Eating	.51
After Dinner Snack	.75
Evening Latency	.75
Eating Window	.80

Note. All correlations are significant at the .01 level.

Final Modifications to the Measure

Some changes were made to the CP as a result of the aforementioned exploration of data and analyses. Because participants were inaccurate in their responses regarding their largest meal, this item was removed from the CP-Q and the CP-D. Therefore, the final version of the CP-Q consists of 17 items, while the final version of the CP-D consists of 23 items (Appendices

E and F). As a result of the removal of this item, possible total scores in the final version of the measure range from 0 to 10, with higher scores reflecting poorer chrononutrition.

DISCUSSION

The present study aimed to develop and evaluate the CP: a novel measure, available in both a questionnaire and diary format, which assesses 5 specific behavioral patterns likely to impact one's chrononutrition profile. These include: 1) night eating, 2) eating window, 3) breakfast skipping, 4) evening eating, and 5) evening latency. Overall, the present study has provided preliminary support for the CP.

Convergent validity analyses showed that CP-Q scores were moderately to strongly correlated to corresponding values from both the PSQI and the ASA24, with the exception of the largest meal. It should be noted that although correlation coefficients may be lower than expected, comparison of mean values for the CP, PSQI, and ASA24 variables indicates a good level of agreement (Table 4). For example, if one considers the mean eating window as assessed by the CP-Q and the ASA24, these values are only different by approximately 30 minutes. Considering this difference within the scope of the entire 24-hour day, this suggests the two measures have relatively good concordance.

Mixed model analyses showed that the CP-D variables were significant predictors of ASA24 variables, and there was overlap in variance explained between the CP-D and the ASA24. Surprisingly, the percentage variance shared between the CP-D and the ASA24 for the last eating event and eating window was fairly small (R^2 = .05 and .06, respectively), although the ASA24 was completed directly after the CP-D. Though this was unanticipated, recent research has found that individuals are more likely to under-report eating events occurring later in the day (i.e., during the afternoon or evening) (Gemming & Mhurchu, 2016) which could account for this finding.

Examination of agreement on the largest meal between the ASA24 and the CP suggested that individuals may not know or may not have the ability to accurately recall the caloric value or their largest meal. This is consistent with past literature indicating that individuals are often biased in reporting caloric intake (Chernev, 2010). Taken together, the level of agreement between the CP and existing measures in the present study indicates that the CP does display convergent validity.

Interpretation of concurrent validity was not possible in the present study. Though CP-D total scores were shown to predict BMI in a hierarchical linear regression, the relationship was opposite that which had been hypothesized, such that increases in CP-D total scores were associated with lower BMI. This finding is inconsistent with much of the existing literature on chrononutrition (e.g., Gill & Panda, 2015; Ma et al., 2003). The additional regression models were not statistically significant, indicating that CP-D total scores were not predictive of general health, and CP-Q scores were not predictive of BMI or general health. Interestingly, REAP total scores were not associated with BMI or with general health, though the links between dietary intake, health, and BMI are well-established. Though REAP scores were negatively correlated with CP-Q total scores (r = -.38), REAP scores were not significantly correlated with CP-D total scores ($p>.05$). To further explore the relationship between specific chrononutrition behaviors and both BMI and general health, analyses of variance (ANOVAs) were conducted. Chrononutrition cutoff scores for four CP-Q chrononutrition behaviors were examined (breakfast skipping, evening eating, evening latency, eating window) to determine whether mean differences in BMI and general health exist, across chrononutrition categorization groups. Results indicated that all ANOVAs were non-significant (all p's > .05), and group means did not display any meaningful patterns (Table 20). Although these analyses did not support the

concurrent validity of the CP, this may be the result of limitations in the methodology and sample characteristics, particularly in light of the nonsignificant relationships also found between dietary intake and BMI and general health.

Table 20

Results of analyses of variance (ANOVAs) in predicting BMI and general health from Chrononutrition Profile – Questionnaire cutoffs

Eating Window	N	Mean (*SD*)	
		BMI	General Health
Good (12:00 or less)	106	24.44 (*4.85*)	66.84 (*18.21*)
Fair (12:01 to 14:00)	22	23.11 (*3.74*)	69.17 (*18.54*)
Poor (> 14:00)	5	22.12 (*2.35*)	67.25 (*23.52*)
F		1.24^{ns}	.15^{ns}
Evening Eating	N		
Good (<20:00)	63	24.32 (*3.85*)	66.27 (*18.37*)
Fair (20:00 to 22:59)	64	23.99 (*5.34*)	68.18 (*18.41*)
Poor (23:00 or later)	6	24.30 (*4.02*)	70.49 (*17.67*)
F		.08^{ns}	.26^{ns}
Evening Latency	N		
Good (>6:00)	12	24.80 (*5.33*)	61.67 (*18.00*)
Fair (2:01 to 6:00)	94	24.43 (*4.81*)	67.26 (*19.03*)
Poor (≤2:00)	27	22.90 (*4.63*)	69.74 (*15.46*)
F		1.28^{ns}	.81^{ns}
Breakfast Skipping	N		
Good (1 or fewer days/week)	46	24.16 (*5.14*)	65.87 (*19.59*)
Fair (2 to 3 days/week)	34	23.93 (*4.65*)	69.74 (*16.80*)
Poor (4 or more days/week)	53	24.37 (*4.18*)	66.60 (*18.11*)
F		.10^{ns}	.48^{ns}

Note. BMI = body mass index.
Note.^{ns} = non-significant at the $p < .05$ level.

In addition to reliance on self-report data, the study sample was primarily Caucasian, female, freshmen, at a healthy weight, and generally healthy. The sample had a low prevalence of night eating; however, estimates suggest that only approximately 3% of U.S. university students suffer from night eating syndrome (Runfola, Allison, Hardy, Lock, & Peebles, 2014). We had also anticipated greater variability in both general health and BMI than was found in the sample. Perhaps this lack of variability would account for the unexpected results. Future studies should address this limitation by evaluating the psychometric properties of the CP in samples with more ethnic, gender, and age diversity, and with more variability in weight and health.

In contrast, the CP-Q provided strong evidence for test-retest reliability, with all variables significantly correlating over the 14- to 21-day period. Two aspects should be noted regarding test-retest-reliability: 1) weekend values were slightly less strongly correlated compared to weekday values, and 2) the correlation coefficient for lunchtime on weekend days was particularly low compared to the other items. This could indicate that overall, chrononutrition on weekend days may be more variable over time than chrononutrition on weekdays, and lunchtime may vary more on weekends compared to the timing of other eating events. Chrononutrition preferences were also strongly correlated over the testing period. Though we did not account for seasonal variation in circadian patterns of eating or sleeping, data were collected rapidly with all recruitment completed within three months and within the same season (February to April). Therefore, these strong correlations indicate that the CP-Q has good test-retest reliability.

The CP is a concise yet thorough measure of chrononutrition which complements existing dietary intake assessments. The ASA24, for example, is quite burdensome for participants and may take as long as 30 minutes to complete (Subar et al., 2012). In addition, completion of the ASA24 requires internet access and may not be feasible for all populations

(e.g., minority groups) (Ettienne-Gittens et al., 2013). Other existing dietary intake assessment methods also have limitations: for example, semi-structured interviews require interviewers to undergo considerable training, while findings from highly-controlled laboratory-based feeding assessments may not generalize to everyday life (for review, see Goldschmidt, 2017). The CP, in contrast, can be completed in just a few minutes. This measure does not require internet access, thus reducing this potential barrier to data collection. In addition, the measure can be administered with little instruction and is designed to assess chrononutrition in a naturalistic setting. Because the CP is a novel measure, this assessment method may also provide a new avenue for weight management efforts.

As part of the present study, during Part 1, 192 participants were asked to indicate their perceptions regarding calorie restriction in an effort to lose weight. Individuals rated their confidence in their ability to restrict their caloric intake, as well as the extent to which they felt restricting calorie intake would disrupt their daily routine, and their estimated level of happiness if they were to restrict their calorie intake. Participants were also asked to choose between restricting calories or restricting their eating window. 42% of participants reported that they would rather restrict their eating window. Results of independent samples t-tests revealed that individuals who stated that they would rather restrict their eating window were significantly less confident in their ability to restrict calories, felt restricting calories would be more disruptive, and reported that they would be less happy than participants who stated they would rather restrict calorie intake, Considering the limited success of many diets (e.g., Nicklas, Huskey, Davis, & Wee, 2012), these preliminary findings indicate that chrononutrition may be a viable weight loss strategy for individuals who do not want to or are unable to change what they eat. If almost half of the millions of Americans with obesity are unlikely to have success with calorie restriction,

other strategies which do not require caloric monitoring should be developed. The CP is one such alternative strategy which can be implemented in a variety of settings.

Both the CP-Q and the CP-D could be used as sole assessments of chrononutrition or as supplements to traditional dietary intake assessments. These measures of the circadian timing of food intake may provide health care professionals, scientists, and stakeholders with a relatively simple and cost-effective assessment that can inform novel and effective prevention and treatment plans for diseases such as obesity, depression, and diabetes. The CP-Q is designed to assess general patterns of chrononutrition on typical days, and can be completed in a single sitting within a few minutes. As such, this measure may be especially valuable in situations such as medical office visits when time is limited but a health care professional wants to assess general chrononutrition to determine potential areas for disease prevention or management. Researchers could also utilize the CP-Q to increase understanding of relationships between chrononutrition preferences and behaviors, and to evaluate the role of chrononutrition preferences in health decision-making (e.g., alcohol use).

Alternatively, the CP-D is intended to assess repeated daily patterns of chrononutrition. This measure could be used to evaluate daily chrononutrition in individuals with overweight and obesity to highlight potential treatment plans. Scientists could also utilize the CP-D to evaluate intra-individual predictors of poor chrononutrition on a day-to-day basis (e.g., stress, food availability, work schedule). Use of the CP-D would require multiple days of data collection, but this measure can also be completed in a few minutes. Because the CP can be utilized in a variety of ways by scientists, healthcare professionals, and stakeholders, this measure, with further research, can help fill significant gaps in our current knowledge.

In sum, a growing body of literature has suggested that *when* food intake occurs is just as important as *what* and *how much* is consumed, though a comprehensive measure of chrononutrition had not yet been developed. Therefore, the present study developed and provided preliminary support for the CP, a brief but thorough assessment of chrononutrition. The CP can be utilized in various research and clinical samples, and it will provide health behavior researchers and health care professionals with a novel assessment method that will serve as a valuable addition to the existing literature.

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APPENDIX A. PRELIMINARY CHRONONUTRITION PROFILE - QUESTIONNAIRE

Directions: The following questions are designed to assess the timing of your eating. Please choose the one response that best fits your behavior and preferences.

If you were entirely free to plan your day,

A1. What time would you prefer to wake up? Please indicate A.M. or P.M. as part of your response.

_____ A.M./ P.M.

A2. How soon after waking up would you prefer to have your first meal or snack of the day?

_____ hours _____ minutes

A3. How much time before bed would you prefer to stop eating?

_____ hours _____ minutes

A4. What time would you prefer to go to bed at night? Please indicate A.M. or P.M. as part of your response.

_____ A.M./ P.M.

In a typical week (a 7-day period),

B1. How often do you eat breakfast?

_____ 0 days
_____ 1 day
_____ 2 days
_____ 3 days
_____ 4 days
_____ 5 days
_____ 6 days
_____ 7 days

B2. What is your largest meal of the day?

_____ Breakfast
_____ Lunch
_____ Dinner/Supper
_____ Other meal (Please describe: _____)

B3. How often do you eat a snack after your last meal of the day?

_____ 0 days
_____ 1 day
_____ 2 days
_____ 3 days
_____ 4 days
_____ 5 days
_____ 6 days
_____ 7 days

B4. How frequently do you wake up in the night to eat?

_____ 0 days
_____ 1 day
_____ 2 days
_____ 3 days
_____ 4 days
_____ 5 days
_____ 6 days
_____ 7 days

On a typical workday or school day,

C1. What time do you wake up? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

C2. What time do you eat your first meal or snack of the day? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

C3. What time do you eat lunch? Please indicate A.M./P.M. as part of your response. Select "I do not eat lunch" if you do not typically eat lunch.

_____ A.M./ P.M.
_____ I do not eat lunch.

C4. What time do you eat your last meal or snack of the day? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

C5. What time do you go to bed? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

On a typical weekend day or free day,

D1. What time do you wake up? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

D2. What time do you eat your first meal or snack of the day? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

D3. What time do you eat lunch? Please indicate A.M./P.M. as part of your response. Select "I do not eat lunch" if you do not typically eat lunch.

_____ A.M./ P.M.

_____ I do not eat lunch.

D4. What time do you eat your last meal or snack of the day? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

D5. What time do you go to bed? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

APPENDIX B. PRELIMINARY CHRONONUTRITION PROFILE - DIARY

Directions: The following questions are designed to assess the timing of your eating from the time you went to bed last night until your bedtime tonight. Please complete the diary each night before bed.

1. What time did you go to bed last night? Please indicate A.M./P.M. as part of your response.

_____ A.M. / P.M

2. Last night, did you wake up in the night to eat?

_____ Yes
_____ No

** **If you selected "No", please skip to question 3**. **

2A. How many times did you wake up to eat last night?

____ 1 time
____ 2 times
____ 3 times
____ 4 times
____ 5 or more times

2B. Altogether, about how long did these awakenings last?

_____ hours
_____ minutes

2C. About what time did you fall back asleep for the night? Please indicate A.M/P.M. as part of your response.

_____ A.M. / P.M.

3. What time did you wake up this morning? Please indicate A.M./P.M. as part of your response.

_____ A.M. / P.M.

4. Did you eat breakfast today?

_____ Yes
_____ No

** **If you selected "No", please skip to question 5**. **

4A. At what time did you eat breakfast today? Please indicate A.M./P.M. as part of your response.

_____ A.M / P.M.

4B. Were you able to eat breakfast at the time you wanted?

_____ Yes
_____ No

4C. If you answered no, what kept you from eating breakfast when you wanted to eat it?

_____

5. Did you eat lunch today?

_____ Yes
_____ No

** **If you selected "No", please skip to question 6**. **

5A. At what time did you eat lunch today? Please indicate A.M./P.M. as part of your response.

_____ A.M. / P.M.

5B. Were you able to eat lunch at the time you wanted?

_____ Yes
_____ No

5C. If you answered no, what kept you from eating lunch when you wanted to eat it?

_____

6. Did you eat dinner/supper today?

_____ Yes
_____ No

** **If you selected "No", please skip to question 7**. **

6A. At what time did you eat dinner/supper today? Please indicate A.M./P.M. as part of your response.

_____ A.M./P.M.

6B. Were you able to eat dinner/supper at the time you wanted?

_____ Yes
_____ No

6C. If you answered no, what kept you from eating dinner/supper when you wanted to eat it?

_____

7. What was your largest meal today?

_____ Breakfast
_____ Lunch
_____ Dinner/Supper
_____ Other meal (Please describe: _____)

8. Did you eat a snack after your last meal of the day?

_____ Yes
_____ No

** **If you selected "No", please skip to question 9.** **

8A. If you did, at what time did you eat this snack? Please indicate A.M./P.M. as part of your response.

_____

9. Were you ill today?

_____ Yes
_____ No

APPENDIX C. INITIAL CHRONONUTRITION PROFILE – QUESTIONNAIRE

Directions: The following questions are designed to assess the general timing of your eating. Please choose the one response that best fits your typical behavior and preferences.

The term "eating event" refers to any time you eat something that contains calories. For example, this could be a meal, a snack, or a drink.

If you were entirely free to plan your day,

A1. What time would you prefer to wake up? Please indicate A.M. or P.M. as part of your response.

_____ A.M./ P.M.

A2. How soon after waking up would you prefer to have your first eating event of the day?

_____ hours _____ minutes

A3. How soon before bed would you prefer to stop eating?

_____ hours _____ minutes

A4. What time would you prefer to fall asleep? Please indicate A.M. or P.M. as part of your response.

_____ A.M./ P.M.

On average, in a typical week (a 7-day period),

B1. How often do you eat breakfast?

_____ 0 days
_____ 1 day
_____ 2 days
_____ 3 days
_____ 4 days
_____ 5 days
_____ 6 days
_____ 7 days

B2. What is your largest meal of the day?

_____ Breakfast
_____ Lunch
_____ Dinner/Supper
_____ Other meal (Please describe:
_____)

B3. How often do you eat a snack after your last meal of the day?

_____ 0 days
_____ 1 day
_____ 2 days
_____ 3 days
_____ 4 days
_____ 5 days
_____ 6 days
_____ 7 days

B4. How often do you wake up in the night to eat?

_____ 0 days
_____ 1 day
_____ 2 days
_____ 3 days
_____ 4 days
_____ 5 days
_____ 6 days
_____ 7 days

On average, on a typical workday or school day,

C1. What time do you wake up? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

C2. What time is your first eating event of the day? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

C3. What time do you eat lunch? Please indicate A.M./P.M. as part of your response. Select "I do not eat lunch" if you do not typically eat lunch.

_____ A.M./ P.M.
_____ I do not eat lunch.

C4. What time is your last eating event before bed? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

C5. What time do you fall asleep? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

On average, on a typical weekend day or free day,

D1. What time do you wake up? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

D2. What time is your first eating event of the day? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

D3. What time do you eat lunch? Please indicate A.M./P.M. as part of your response. Select "I do not eat lunch" if you do not typically eat lunch.

_____ A.M./ P.M.

_____ I do not eat lunch.

D4. What time is your last eating event of the day before bed? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

D5. What time do you fall asleep? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

APPENDIX D. INITIAL CHRONONUTRITION PROFILE - DIARY

Directions: The following questions are designed to assess the timing of your eating from the time you went to bed last night until your bedtime tonight. Please complete the diary each night before bed.

1. What time did you fall asleep last night? Please indicate A.M./P.M. as part of your response.

_____ A.M. / P.M

2. Last night, did you wake up in the night to eat?

_____ Yes
_____ No

** **If you selected "No", please skip to question 3**. **

2A. How many times did you wake up to eat last night?

____ 1 time
____ 2 times
____ 3 times
____ 4 times
____ 5 or more times

2B. Altogether, about how long did these awakenings last?

_____ hours _____ minutes

2C. What time did you fall back asleep for the night? Please indicate A.M/P.M. as part of your response.

_____ A.M. / P.M.

3. At what time did you wake up this morning? Please indicate A.M./P.M. as part of your response.

_____ A.M. / P.M.

4. Did you eat breakfast today?

_____ Yes
_____ No

** **If you selected "No", please skip to question 5**. **

4A. At what time did you eat breakfast today? Please indicate A.M./P.M. as part of your response.

_____ A.M / P.M.

4B. Were you able to eat breakfast at the time you wanted?

_____ Yes
_____ No

4C. If you answered no, what kept you from eating breakfast when you wanted to eat it?

_____

5. Did you eat lunch today?

_____ Yes
_____ No

** **If you selected "No", please skip to question 6**. **

5A. At what time did you eat lunch today? Please indicate A.M./P.M. as part of your response.

_____ A.M. / P.M.

5B. Were you able to eat lunch at the time you wanted?

_____ Yes
_____ No

5C. If you answered no, what kept you from eating lunch when you wanted to eat it?

_____

6. Did you eat dinner/supper today?

_____ Yes
_____ No

** **If you selected "No", please skip to question 7**. **

6A. At what time did you eat dinner/supper today? Please indicate A.M./P.M. as part of your response.

_____ A.M./P.M.

6B. Were you able to eat dinner/supper at the time you wanted?

_____ Yes
_____ No

6C. If you answered no, what kept you from eating dinner/supper when you wanted to eat it?

_____

7. What was your largest meal today?

_____ Breakfast
_____ Lunch
_____ Dinner/Supper
_____ Other meal (Please describe:
_____)

8. Did you eat anything (including snacks or drinks) after your last meal of the day, before bed?

_____ Yes
_____ No

** **If you selected "No", please skip to question 9.** **

8A. If you did, at what time did you eat this snack? Please indicate A.M./P.M. as part of your response.

_____ A.M./P.M.

9. Were you ill today?

_____ Yes
_____ No

10. Would you consider today to be a weekday or a weekend day?

_____ Weekday
_____ Weekend

11. Was today a normal day?

_____ Yes
_____ No

APPENDIX E. FINAL CHRONONUTRITION PROFILE – QUESTIONNAIRE

Directions: The following questions are designed to assess the general timing of your eating. Please choose the one response that best fits your typical behavior and preferences.

The term "eating event" refers to any time you eat something that contains calories. For example, this could be a meal, a snack, or a drink.

If you were entirely free to plan your day,

A1. What time would you prefer to wake up? Please indicate A.M. or P.M. as part of your response.

_____ A.M./ P.M.

A2. How soon after waking up would you prefer to have your first eating event of the day?

_____ hours _____ minutes

A3. How soon before bed would you prefer to stop eating?

_____ hours _____ minutes

A4. What time would you prefer to fall asleep? Please indicate A.M. or P.M. as part of your response.

_____ A.M./ P.M.

On average, in a typical week (a 7-day period),

B1. How often do you eat breakfast?

_____ 0 days
_____ 1 day
_____ 2 days
_____ 3 days
_____ 4 days
_____ 5 days
_____ 6 days
_____ 7 days

B2. How often do you eat a snack after your last meal of the day?

_____ 0 days
_____ 1 day
_____ 2 days
_____ 3 days
_____ 4 days
_____ 5 days
_____ 6 days
_____ 7 days

B3. How often do you wake up in the night to eat?

_____ 0 days
_____ 1 day
_____ 2 days
_____ 3 days
_____ 4 days
_____ 5 days
_____ 6 days
_____ 7 days

On average, on a typical workday or school day,

C1. What time do you wake up? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

C2. What time is your first eating event of the day? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

C3. What time do you eat lunch? Please indicate A.M./P.M. as part of your response. Select "I do not eat lunch" if you do not typically eat lunch.

_____ A.M./ P.M.
_____ I do not eat lunch.

C4. What time is your last eating event before bed? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

C5. What time do you fall asleep? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

On average, on a typical weekend day or free day,

D1. What time do you wake up? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

D2. What time is your first eating event of the day? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

D3. What time do you eat lunch? Please indicate A.M./P.M. as part of your response. Select "I do not eat lunch" if you do not typically eat lunch.

_____ A.M./ P.M.

_____ I do not eat lunch.

D4. What time is your last eating event of the day before bed? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

D5. What time do you fall asleep? Please indicate A.M./P.M. as part of your response.

_____ A.M./ P.M.

APPENDIX F. FINAL CHRONONUTRITION PROFILE - DIARY

Directions: The following questions are designed to assess the timing of your eating from the time you went to bed last night until your bedtime tonight. Please complete the diary each night before bed.

1. What time did you fall asleep last night? Please indicate A.M./P.M. as part of your response.

_____ A.M. / P.M

2. Last night, did you wake up in the night to eat?

_____ Yes
_____ No

** **If you selected "No", please skip to question 3**. **

2A. How many times did you wake up to eat last night?

____ 1 time
____ 2 times
____ 3 times
____ 4 times
____ 5 or more times

2B. Altogether, about how long did these awakenings last?

_____ hours _____ minutes

2C. What time did you fall back asleep for the night? Please indicate A.M/P.M. as part of your response.

_____ A.M. / P.M.

3. At what time did you wake up this morning? Please indicate A.M./P.M. as part of your response.

_____ A.M. / P.M.

4. Did you eat breakfast today?

_____ Yes
_____ No

** **If you selected "No", please skip to question 5**. **

4A. At what time did you eat breakfast today? Please indicate A.M./P.M. as part of your response.

_____ A.M / P.M.

4B. Were you able to eat breakfast at the time you wanted?

_____ Yes
_____ No

4C. If you answered no, what kept you from eating breakfast when you wanted to eat it?

_____

5. Did you eat lunch today?

_____ Yes
_____ No

** **If you selected "No", please skip to question 6**. **

5A. At what time did you eat lunch today? Please indicate A.M./P.M. as part of your response.

_____ A.M. / P.M.

5B. Were you able to eat lunch at the time you wanted?

_____ Yes
_____ No

5C. If you answered no, what kept you from eating lunch when you wanted to eat it?

_____

6. Did you eat dinner/supper today?

_____ Yes
_____ No

** **If you selected "No", please skip to question 7**. **

6A. At what time did you eat dinner/supper today? Please indicate A.M./P.M. as part of your response.

_____ A.M./P.M.

6B. Were you able to eat dinner/supper at the time you wanted?

_____ Yes
_____ No

6C. If you answered no, what kept you from eating dinner/supper when you wanted to eat it?

_____

7. Did you eat anything (including snacks or drinks) after your last meal of the day, before bed?

_____ Yes
_____ No

** **If you selected "No", please skip to question 9.** **

7A. If you did, at what time did you eat this snack? Please indicate A.M./P.M. as part of your response.

_____ A.M./P.M.

8. Were you ill today?

_____ Yes
_____ No

9. Would you consider today to be a weekday or a weekend day?

_____ Weekday
_____ Weekend

10. Was today a normal day?

_____ Yes
_____ No