Chronotype Differences in Body Composition, Dietary Intake and Eating Behavior Outcomes – A Scoping Systematic Review

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Online Supplementary Material

Supplementary Table 1: PICOS Table

Review question	**Is body composition, dietary intake, eating behaviour and biomarker outcomes in healthy adults dependent on chronotype?**
Population	Inclusion criteria: Healthy adults 18 years and older. Exclusion criteria: Individuals <18 years; pregnant and lactating women, night shift workers, diagnosed acute, pre-existing and chronic diseases (e.g., eating disorders, trauma, surgical or hospitalized patients, depression, mental illness, sleep disorders, diabetes and hypertension).
Intervention	Classification according to chronotype using validated chronotype questionnaires such as the Munich Chronotypes Questionnaire and the Morning-Eveningness Questionnaire as well as studies using mid-point of sleep to define chronotype.
Comparator	Body composition profile (BMI, body fat profiles, waist- and hip circumference, etc.).
Outcomes	Must include one of the following: Dietary intake (total and distribution of macro- and micronutrient intakes as well as food group intakes), and/or Eating behaviors/habits (meal timing, meal frequency, binge eating, perceived hunger, eating restraint, eating control, emotional eating, eating context e.g. meal intake while watching television, emotional eating and other relevant behaviors) and/or Biomarkers (such as blood glucose, glycated hemoglobulin levels, lipid profiles, liver function, endocrine regulators, and other relevant biomarkers and hormone levels).
Study design	All relevant study design except for conference proceedings, editorial letters, review articles and pharmacological studies.

Supplementary Table 2: The Joanna Briggs Institute Critical Appraisal Checklists for Analytical Cross-Sectional Studies

Reference	**Criteria for sample inclusion clearly defined?**	**Study subjects and setting described in detail?**	**Exposure measured in a valid and reliable way?**	**Objective, standard criteria used for measurement of the condition?**	**Confounding factors identified?**	**Strategies to deal with confounding factors stated?**	**Outcomes measured in a valid and reliable way?**	**Appropriate statistical analysis used?**	**Score /8**
Sato-Mito et al., 2011 (56)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Vera et al., 2018 (71)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Najem et al., 2020 (76)	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	6
Lázár et al., 2012 (73)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Yoshizaki et al., 2018 (59)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Silva et al., 2016 (60)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Lai & Say, 2013 (61)	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7
Lucassen et al., 2013 (62)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Mota et al., 2016 (63)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Zerón-Rugerio et al., 2019 (64)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Maukonen et al., 2017 (79)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Maukonen et al., 2016 (65)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Teixeira et al., 2018 (66)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8

Reference	Criteria for sample inclusion clearly defined?	Study subjects and setting described in detail?	Exposure measured in a valid and reliable way?	Objective, standard criteria used for measurement of the condition?	Confounding factors identified?	Strategies to deal with confounding factors stated?	Outcomes measured in a valid and reliable way?	Appropriate statistical analysis used?	Score /8
Li et al., 2018 (74)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
De Amicis et al., 2020 (67)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Baron et al., 2011 (75)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Baron et al., 2013 (68)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Beaulieu et al., 2020 (69)	Yes	Unclear	Yes	Yes	Unclear	Unclear	Yes	Yes	5
Muscogiuri et al., 2020 (70)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Zerón-Rugerio et al., 2020 (58)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8

Supplementary Table 3: Joanna Briggs Institute Critical Appraisal Checklists for Cohort Studies

Reference	**Groups similar/ from same population?**	**Exposures measured similarly to assign people to both exposed & unexposed groups?**	**Exposure measured in a valid and reliable way?**	**Confounding factors identified?**	**Strategies to deal with confounding factors stated?**	**Participants free of the outcome at start of study (or at the moment of exposure)?**	**Outcomes measured in a valid and reliable way?**	**Follow up time reported & sufficient for outcomes to occur?**	**Follow up complete, and if not, were the reasons to loss to follow p described and explored?**	**Strategies to address incomplete follow up utilised?**	**Appropriate statistical analysis used?**	**Score /12**
Xiao et al., 2019 (77)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	12
Maukonen et al., 2019 (78)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	12
Culnan et al., 2013 (72)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	11

Supplementary Table 4: The Joanna Briggs Institute Critical Appraisal Checklists for Randomised Controlled Trials

Refe-rence	**True randomi-sation used for assignment of participant s to treatment groups?**	**Allocation to treatment groups concealed**	**Treat-ment groups similar at baseline**	**Partici-pants blind to treatment assignment**	**Those delivering treatment blind to treatment assignment**	**Outcome assessors blind to treatment assignment**	**Treatment groups treated identically other than the intervention**	**Follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed**	**Participants analysed in the groups to which they were randomised**	**Outcomes measured in the same way for treatment groups**	**Were outcomes measured in a reliable way**	**Appro-priate statistical analysis used**	**Score /12**
Muñoz, 2020 (57)	Yes	Yes	Yes	Yes	Yes	Unsure	Yes	Yes	Yes	Yes	Yes	Yes	11

Supplementary Table 5: Chronotype Classification Methods

Reference	**Questionnaire used and method of chronotype classification**
Xiao et al., 2019 (77)	MCTQ MT was defined when midsleep was earlier than median midsleep i.e., before 3:04 AM. ET was defined for median midsleep later than 3:04 AM.
Sato-Mito et al., 2011 (56)	MEQ Participants reported bedtimes and rise times in a lifestyle questionnaire as the time when they usually went to bed on weekdays and when they arose in the morning. The midpoint of sleep was calculated as the halfway point between bedtime and rise time. Participants were assigned to quintiles according to their midpoint of sleep, from the earliest Q1: (2:32 ± 0:23 h: min), (Quintile 2: (3:10 ± 0:08 h: min, (Quintile 3: 3:37 ± 0:07 h: min), (Quintile 4: 4:11 ± 0:13 h:min) to the latest quintile (Q5: 5:31 ± 0:55 h: min).
Vera et al., 2018 (71)	MEQ The score was divided into “more evening” and “more morning” type based on the median MEQ score of the total population (i.e., a score <53: more evening; a score ≥53: more morning).
Najem et al., 2020 (76)	MEQ The following MEQ scores were used to assign participants to different chronotype groups: Definite ET: ≤ 30 Moderate ET: 31 - 41 IT: 42 - 58 Moderate MT: 59 - 69 Definite MT: 70 - 86
Lázár et al., 2012 (73)	MEQ The total score of the MEQ and the single question from the Munich Chronotype Questionnaire referring to self-assessed chronotype were used.
Yoshizaki et al., 2018 (59)	MEQ Participants were divided into tertials according to the MEQ score: Moderate ET: 1st third: 34 – 53 Intermediate: 2nd third: 54 – 59 MT: 3rd third: 60 – 76

Reference	Questionnaire used and method of chronotype classification
Silva et al., 2016 (60)	MEQ Chronotype was defined using midsleep time on free days and a correction for sleep duration on work and free days by using the difference between weighted? average sleep duration on weekends and on weekdays.
Lai & Say, 2013 (61)	MEQ Participants were divided into chronotypes according to the MEQ score: IT: 42 – 58 Definitely ET: 16 - 30 Moderately ET: 31 - 41
Muñoz, 2020 (57)	MEQ Participants with a low MEQ score (16-51 points), were assigned to ET, and those with high scores (52-86 points) were assigned to MT.
Lucassen et al., 2013 (62)	MEQ Participants were divided into chronotypes according to the MEQ score where MT includes moderate and definite MT and vice versa for ET: Score range: 16–86 MT (50–86) ET (16–49)
Mota et al., 2016 (63)	MEQ Participants were classified as ET (16–41), IT (42–58) or MT (59–86).
Zerón-Rugerio et al., 2019 (64)	MEQ Score range: 10–86. Participants were classified as IT (42–58), MT (>58) or ET (<42).
Maukonen et al., 2019 (78)	MEQ (short version) The sum MEQ of the final short version of the MEQ score ranged from 6 to 27. Participants were classified into ET (6–12), IT (13–18) and MT (19–27).
Maukonen et al., 2017 (79)	MEQ (short version) Participants were classified into ET (6–12), IT (13–18) and MT (19–27).
Maukonen et al., 2016 (65)	MEQ (short version) The final MEQ score varied from 5 (extreme ET) to 27 (extreme MT). Tertials were used for analysis (MT, IT and ET).
Teixeira et al., 2018 (66)	MEQ Participants were assigned to ET (coefficient: 16–41), IT (coefficient: 42–58) or MT (coefficient: 59–86).

Reference	Questionnaire used and method of chronotype classification
Li et al., 2018 (74)	MEQ The MEQ scores range from 59 to 86, the intermediate scores range from 42 to 58, and the ET scores range from 16 to 41.
De Amicis et al., 2020 (67)	MEQ (short version) The final MEQ score ranged from < 12 (extreme ET) to > 17 (extreme MT). Intermediate scores were associated with IT (12–17 points).
Culnan et al., 2013 (72)	MEQ (short version) Participants were classified into ET (6–12), IT (13–18) and MT (19–27).
Baron et al., 2011 (75) and Baron et al., 2013 (68)	MEQ The MEQ scores range from 16 to 86, with higher scores indicating greater preference for morning. Participants were dichotomized as IT if their midpoint of sleep was between 1:00 am to 5:29 am, and as ET if midpoint of sleep was 5:30 am or later, which was past the 50th percentile of sleep times in the population (4:00 am).
Beaulieu et al., 2020 (69)	MEQ Chronotype classification was determined by MEQ score median split, stratified for sex (calculated separately for each sex). MEQ scores range between 16–86.
Muscogiuri et al., 2020 (70)	(MEQ) (short version) The MEQ scores ranged from 16 to 86. Participants were classified as being a MT (59–86), IT (42–58), or ET (16–41) based on their MEQ score.
Zerón-Rugerio et al., 2020 (58)	(MEQ) Participants completed a 6-day sleep diary on consecutive days (including 3 weekdays and 2 weekend days) in which they recorded bedtime and wakeup timing. From this data, the midpoints of sleep were calculated. Sleep timing was classified using the median splits of the time in which each subject went to bed and woke up during the week. Bedtime was classified as follows: “Early-bedtime” (<23:48 h) and “Late-bedtime” (≥23:48 h). Then, for each bedtime group, the median splits of wakeup timing were used. Early-bedtime Participants were divided into “Early-rise” (wakeup time <7:12 h) and “Late-rise” (wakeup time ≥ 7:12 h). “Late-bedtime” Participants were divided into “Early-rise” (wakeup time <7:52 h) and “Late-rise” (wakeup time ≥ 7:52 h).

Reference	Questionnaire used and method of chronotype classification
	Consequently, four sleep timing categories were defined: early-bedtime/early-rise (EE), early-bedtime/late-rise (EL), late-bedtime/early-rise (LE), and late-bedtime/late-rise (LL). We assigned LL to ET and EE to MT and EL and LE to IT in the manuscript.