

# Time restricted feeding for the prevention and therapy of lifestyle-dependent diseases: Results of a pilot study in a pre-post design

Dorothea Kesztyüs (✉ [dorothea.kesztyues@uni-ulm.de](mailto:dorothea.kesztyues@uni-ulm.de))

Ulm University <https://orcid.org/0000-0002-2166-846X>

Dorothee Schönsteiner

Universitätsklinikum Ulm

Markus Gulich

Universität Ulm

Tibor Kesztyüs

Technische Hochschule Ulm



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## Research article

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# Abstract

## Background

The on-going epidemic of non-communicable diseases in industrialised countries threatens to overtax the health and social systems of these nations. New approaches beyond the usual therapeutic and preventive measures which have been applied so far must be tested. A paradigm shift with regard to nutrition and associated illness is overdue. Time-restricted feeding (TRF) offers a low threshold and easy to implement lifestyle change which may have what it takes for broad, population-wide applicability and a widely diversified range of possible effects. In this pilot study we will examine the feasibility and adherence of TRF in healthy adult employees.

## Methods

Pre-post-design study with healthy volunteers from the staff of Ulm University and Ulm University Hospital. Participants were asked to reduce their daily eating time to 8-9 hours for three months. Surrounding the eating time they were allowed drinks other than water for 12 hours and water for the rest of the day. Anthropometric measurements were taken by trained staff and blood samples were taken at baseline and follow-up. Questionnaires were handed out pre and post and during the course of the study timing of the first and the last meal, as well as sleep duration and quality, were assessed in diaries.

## Results

Sixty three participants (aged  $47.8 \pm 10.5$ ) were recruited and started the intervention immediately after the baseline assessment. Two persons dropped out while all others finished the study. Ratings of compatibility of TRF with professional activities were good in 78% of participants while 18% reported to have encountered some difficulties. On average, the fasting target was reached on  $72.2 \pm 18.9\%$  of recorded days. After three months of TRF, participants showed moderate reductions in weight ( $-1.3 \pm 2.3\text{kg}$ ,  $p < 0.001$ ) and waist circumference ( $-1.7 \pm 3.22\text{cm}$ ,  $p < 0.001$ ). Health-related quality of life increased significantly by  $5.8 \pm 12.4$  ( $p = 0.008$ ) points between baseline and follow-up.

## Conclusions

TRF is feasible and well accepted, even in regularly employed persons, and improves HRQoL. TRF may help to reduce obesity and abdominal obesity in adult working people and so help to prevent non-communicable diseases, but volunteers need more guidance to increase effects.

# Background

The development of lifestyle-related diseases such as type II diabetes, cardiovascular disease, various cancers and chronic lung diseases is often correlated with overweight and obesity. The prevalence of overweight, obesity and abdominal obesity in the population is high and increases with age (1). To date, no effective therapy or preventive measure has been found against the epidemic spread of obesity. A lasting change in lifestyle offers the greatest chance of preventing weight gain or achieving weight reduction (2). Such lifestyle changes, which include an increase in physical activity and a change in eating habits, show good results under study conditions, but are rarely continued by those affected in the long term (3). Nevertheless, the interest in diets or special forms of nutrition among the population remains unbroken. A relatively new trend is so-called intermittent fasting. Here

the calorie supply is regularly reduced to  $\pm 500$  kcal on fasting days. This can be alternated every second day (1:1), but also on one (6:1) or two non-consecutive days (5:2) of a week, whilst for the remaining days normally or ad libitum eating is intended, whereby the calories saved can be compensated (4). This so-called "fasting mimicking diet" comprises of five days of calorie-reduced eating in three months, whereby the admission of proteins is likewise strongly reduced in order to simulate an approximate complete food renouncement with a special combination of plant-based food (5). All concepts of intermittent fasting described here, however, have in common a reduced calorie intake on certain days. Altogether, successful intervention studies are available for these fasting forms, which confirm their effectiveness (6). However, a certain degree of willpower and discipline is required for a consistent performance.

The so-called "time-restricted feeding" (TRF) regimen, however, works without a compulsory reduction in calories. As a general rule, people eat in a daily eight-hour time window, followed by a 16-hour fasting phase ("16/8"). This form of fasting, which has already been successfully tested in animal experiments, has a positive effect both on weight and on various metabolic parameters and may even alleviate the consequences of a Western diet. To date, there are only very few studies available in humans, but these also show positive effects on the weight and metabolic parameters (4).

The study presented here investigates first and foremost the feasibility and adherence to an 8–9 hour limited period of food intake in everyday working life for healthy adult employees of the University and the University Hospital of Ulm. The study was registered with the German Register of Clinical Trials in 2018 (DRKS-ID: DRKS00015057).

## Methods

This TRF study was conducted in a pre-post design without a control group due to the pilot character of the study. The data collected were pseudonymized using a code to be created individually by the participant. The intervention took place over a period of three months from September to December 2018. The primary target was the percentage of successful days with the planned restriction of the time of food intake in the total study period. Secondary targets were mean differences between pre- and post-values in anthropometry, laboratory parameters, health-related quality of life (HRQoL) and sleep duration and quality.

A written informed consent was available for all participants included in the study. The ethics commission of the University of Ulm approved the study.

## Recruiting

Employees of the university and the hospital were informed about the study via flyers and in a lecture on TRF in the context of the operational health management of the Ulm University in July 2018. Interested volunteers registered at the study centre in the Institute of General Practice. Participation was limited to adult employees without known metabolic pre-existing conditions. The number of participants was raised from 50 to 63 due to the great interest and the achievement of the recruitment target after only two weeks, and also in order to increase the proportion of male participants, which was basically very low.

## Data assessment

The initial examinations started in September 2018 and took place over a period of three weeks. The participants were informed in detail about the content of the study and the implementation of the intervention. They received

an information brochure and completed a questionnaire. The anthropometric measurements were carried out according to a standardised protocol. The participant's height was measured to the nearest 0.1 cm (Stadiometer, Seca®, Germany), and body weight to the nearest 0.1 kg using calibrated and balanced portable digital scales (Seca®, Germany). Waist circumference (WC) was measured in the middle, between the iliac crest and the lower ribcage, using a flexible metal tape (Lufkin Industries Inc., Texas, USA) (7). The Body Mass Index (BMI) was calculated (body weight/height in meters<sup>2</sup>) and classified into normal weight (< 25), overweight (≥ 25), and obese (≥ 30). The Waist-to-Height Ratio (WHtR) was calculated (WC/body height) and categorized as abdominal obesity from a threshold of 0.5. A blood sample was drawn to determine metabolic parameters and inflammation markers.

During the three-month intervention period, the participants documented their meal times, as well as the duration and quality of sleep, the latter on a visual analogue scale, in a pre-printed diary.

In December 2018, the follow-up examinations were carried out according to the same principle as the initial examinations, with questionnaires, anthropometry and blood sampling.

In addition to information on lifestyle and health, the pre-questionnaire collected general data on occupational activity. The post-questionnaire then referred to possible changes in lifestyle and health in the past three months, as well as to questions about the implementation of the intervention. HRQoL was assessed by the visual analogue scale (VAS) taken from the EQ-5D (8).

## Statistical analysis

The basic characteristics were considered descriptively for men, women and the whole group. Group differences between men and women were examined in dependence of scale level and distribution with Fisher's exact test for categorical data and with Mann-Whitney-U, t-Test or Welch-Test (for variance heterogeneity) for continuous data.

For the primary target adherence and feasibility a descriptive evaluation with mean value, standard deviation, and range or frequency measures were calculated.

For the secondary targets, the mean difference between pre- and post-values was considered. The inference statistics were calculated according to the distribution and the scale level with a t-test for connected data or a Wilcoxon rank sum test.

Correlations between continuous variables were tested with the Pearson product-moment correlation coefficient.

The significance level for two-sided tests was set at  $\alpha = 0.05$ .

## Results

Of the 63 participants included, two discontinued the study during its course due to illness and occupational stress. Two other participants were unable to maintain the restricted 8–9 hours of food intake due to incompatibility with family eating habits and illness, but continued the diary and participated in the final examination.

The baseline characteristics of the participants are shown in Table 1.

On average, participants were able to reach the fasting goal of 15–16 h in  $72.2 \pm 18.9\%$  of all recorded days (see Fig. 1). There was considerable heterogeneity between participants regarding the individual percentage of reaching the fasting goal from 16.9% up to 97.7%. Information from the diaries regarding daily eating and fasting time, sleep duration and sleep quality is depicted in Table 3. Furthermore, the average fasting time of participants is illustrated in Fig. 2. For all outcome variables, no differences between weight groups (overweight, obese, abdominal obese) were detected, with exception for sleep duration which was, on average, 18 min shorter in overweight participants ( $p = 0.19$ ).

After three months of TRF, participants showed moderate reductions in weight ( $-1.3 \pm 2.3$  kg) and WC ( $-1.7 \pm 3.22$  cm). The reductions in weight were negatively correlated with both the percentage of reaching the fasting goal ( $r = -.295$ ,  $n = 61$ ,  $p = .021$ ) and the average duration of fasting ( $r = -.306$ ,  $n = 61$ ,  $p = .017$ ). There was a slight increase in total cholesterol ( $0.34 \pm 0.51$  mmol/l) which showed no significant correlation with the percentage of reaching the fasting goal or the average duration of fasting. HRQoL increased significantly by  $5.8 \pm 12.4$  points between baseline and follow-up. This increase was neither correlated with fasting intensity nor with reductions in weight or WC. More details are given in Table 2.

## Side effects

Feeling hungry several times a week or on a daily basis was stated by 35% of participants. Cravings, dizziness, nausea, or other side effects were reported by 29%, 24%, 15%, and 22%, respectively. Other side effects included circulatory problems, weakness, stomach pain, and headaches. Thirty-one percent of side effects were only at the beginning of TRF, 49% occurred less than once a week or once a week, and 20% several times a week or daily. Forty-five percent reported that the side effects had improved during the course of the study, 28% claimed to have experienced no side effects.

## Participants' assessment

The majority of the participants (78%) were able to combine TRF well with their professional activities, 18% reported encountering some difficulties. One participant dropped out because of occupational stress. More than half of the participants (53%) found it easy to stick to the restricted eating time, 25% said that it was difficult for them. Sixty percent rated TRF as positive for their health, 35% neither positive nor negative and 5% as rather negative. Forty-one percent said they wanted to continue TRF, 55% were undecided, and 3% did not want to continue. Most participants (74%) would recommend TRF to others, 24% were undecided and 2% did not want to recommend it. More than half (51%) would welcome it if TRF was offered preventively or therapeutically by their family doctor as an accompanied measure, 34% were undecided, and 15% were not interested. Finally, 34% rated their diet during TRF as better, 46% as equal, and 20% as worse than before. The proportion of participants who claimed to care for, or strongly care for, their health increased from 58% at baseline to 72% at follow-up.

## Discussion

The primary target to investigate the adherence and feasibility of TRF in an adult working population showed good results in both areas. Participants reached the fasting goal in 72% of recorded days and 78% reported good compatibility with their professional activity. This compatibility applies here to employees of a university, which are, however, composed of many different occupational groups with different tasks. Thus TRF may have the potential to be conducted in a considerable proportion of the adult working population.

With an average loss of  $-1.3 \pm 2.3$  kg in weight and  $-1.7 \pm 3.2$  cm in WC, mean differences were only small between baseline and follow-up data. Though there was considerable heterogeneity between participants and weight change ranged from  $-8.9$  kg to  $+3.2$  kg while changes in WC were between  $-13.3$  cm and  $+4.1$  cm. Changes in blood lipids showed more homogeneity but did not deliver the expected improvements, apart from in individual cases. Overall, these results are unsatisfactory with respect to the positive results from trials with rodents (9). In addition to the fact that humans are not kept in cages and the feed supply can be controlled both in terms of time and quantity, one important reason is assumed in the absence of any dietary requirements or instructions. As a consequence some participants reported overeating because of fear of hunger in the fasting phase. For instance, one participant reported to have gobbled up anything he could find by the end of the eating phase. In future studies, this problem has to be explicitly addressed and participants should be given more instructions in terms of nutrition and they need to be looked after more closely.

Independent of changes in body composition, there was a statistically and clinically significant increase in health-related quality of life. Although patient-reported outcomes are constantly gaining more interest and acknowledgment, this is to our knowledge one of the first measurements of HRQoL in intermittently fasting adults (10). This result is especially important because it shows an increase in HRQoL independent of weight loss. Based on the complexity of HRQoL (11), it can be assumed that TRF may have positive physical and psychological effects which to specifically identify exceeds the possibilities of this study.

There are few studies with small numbers of participants examining TRF in humans. Using a mobile app, Gill and Panda observed erratic eating patterns highly variable from day to day with more than half of the 47 participating adults eating for 15 hours, or longer, every day. Furthermore, they report a bias toward eating late and consuming  $>35\%$  of calories after 6 p.m. Eight overweight individuals who reduced their daily eating time from  $>14$  hrs to 10–11 hrs for 16 weeks subsequently reduced their body weight by 3.27 kg (95% CI: 0.908–5.624 kg). In our study, 18 overweight participants reduced their weight by 1.38 kg (95% CI: 0.039–2.717 kg) in 12 weeks, the difference may be due to longer duration and regular individualized feedback in the study by Gill and Panda (12). Additionally, as indicated by small but significant changes in WC and WHtR in our study, TRF may help to loose abdominal fat, an important fact for overall health since abdominal obesity is associated with virtually all kinds of non-communicable diseases and successful interventions are rare (13). Gabel et al. report the effects of a pilot study of 8-hour TRF on body weight and metabolic disease risk factors in 23 obese adults. Participants were allowed ad libitum eating between 10:00 and 18:00 h and water fasting from 18:00 to 10:00 h for 12 weeks. They compared weight loss and other outcomes to a matched historical control group. Except for moderate changes in body weight ( $-2.6\%$ ), energy intake and systolic blood pressure all other variables under consideration (LDL, HDL, triglycerides, fasting glucose, fasting insulin, HOMA-IR, homocysteine) showed no significant differences to controls (14). The 11 obese participants in our study lost  $-2.2\%$  body weight confirming the moderate effects of a TRF regimen with ad libitum eating in obese participants.

Gasmi et al. investigated the influence of 12 weeks TRF on muscle performance and immune responses in 20- and 50-year-old men in groups of 10 persons each. They report that their 12 h feeding – 12 h fasting protocol decreases hematocrit, total white blood cells, lymphocytes, and neutrophils but did not affect muscle performance (15). Two other studies independently report results of randomised trials investigating TRF in young males performing resistance training. Moro et al. found a decrease in fat mass in the TRF group while fat-free mass and maximal strength were maintained (16). Tinsley et al. report no changes in total body composition after the eight-week study period in the TRF group despite a reduced energy intake (16). These findings confirm

the results from Gasmi et al. that TRF does not restrict the practice of exercise training. This is of course very important since fasting has always been associated with, and criticized for, muscle loss. Though not scientifically approved, TRF has as “Leangains”, a large group of fans in the adherers of the fitness scene, or power athletes and bodybuilders, with the important message that fasting does not compulsorily mean a loss of energy and subsequent muscle performance (17).

Finally, Sutton et al. report a controlled feeding study with early TRF (eTRF) and the improvement of insulin sensitivity, blood pressure and oxidative stress, without weight loss, in pre-diabetic men. Early TRF means that the eating window opens early in the morning, and in this case participants started to eat at 8am and had their last meal before 2 pm. The underlying rationale is to eat in accordance with the circadian rhythms in metabolism. The control group had an identical meal plan, except for the timing, which started at 8am and ended at 8 pm. The authors wanted to know, whether their eTRF schema produces health benefits even without losing weight. After five weeks of controlled feeding, insulin sensitivity and  $\beta$ -cell function increased while postprandial insulin, blood pressure, oxidative stress and appetite in the evening were reduced in the eTRF group (18). Participants in our study had their first meal on average at 10:25am and their last meal at 6:46 pm, and supposedly many of them skipped breakfast. There is evidence from several studies in human and animals that eating at the time of the highest responsiveness of the endocrine system during the active phase of the day in accordance with the circadian rhythm optimizes the body's food processing capacity (19). Based on evidence mainly from animal studies, Patterson et al. propose a potential mode of action of intermittent fasting (IF), respectively TRF: The association of IF with lifestyle (diet, sleep and activity), the circadian central and peripheral clocks, and the diversity and activity of the intestinal microbiota, may result in a metabolic regulation and subsequent reductions in obesity and other lifestyle-dependent diseases (20).

TRF offers several advantages over other forms of dietary interventions to prevent or treat weight problems and associated disease or disease risks:

TRF offers several advantages over other forms of dietary interventions to prevent or treat weight problems and associated disease or disease risks:

- Low-threshold approach (meaning that the implementation does not necessarily have to be medically supervised)
- No calorie counting
- No dietary restrictions
- Individually adaptable to the daily rhythm
- TRF may improve health even without weight loss

These advantages may be partly counteracted by some pitfalls:

- Continuation of a possibly unhealthy food selection
- Risk of overcompensation due to increased eating during the eating phase

The advantages of TRF make this approach particularly interesting for public health interventions, as the low barriers and ease of implementation can have a positive impact on both entry and adherence. Nonetheless, more research is needed to clearly identify positive and negative impacts in order to weigh the benefits against the risks.

# Strengths and Limitations

We had only two drop-outs due to comprehensible reasons, which we consider very few. Overall, the adherence was very good thanks to the motivated participants. In comparison to earlier studies with observational character conducted by the authors, the number of missing data was very small. Unfortunately, the visual analogue scale for the HRQoL was printed on the last page of the questionnaire so that 11 participants simply overlooked it in the baseline assessment. A minor strength of this research is probably a larger sample size than previous studies. With respect to the primary target of the study, one of the strengths is the heterogeneity of the participants with regard to their different professional activities.

The most obvious limitation is the missing control group. This was mainly due to the pilot character of the study and the primary targets, for which a control group was not absolutely necessary. Results need therefore be interpreted with caution. Unfortunately, males are underrepresented, possibly reflecting their less pronounced interest in health. This study was not funded and therefore some examinations which would have been useful could not be carried out for financial reasons.

## Conclusion

TRF is feasible and well accepted, even in regularly employed persons, and improves HRQoL independent of changes in bodyweight. Furthermore, TRF may help to reduce obesity and abdominal obesity in adult working people and so help to prevent non-communicable diseases, but volunteers need more guidance to increase effects.

Further well designed studies are necessary to fully investigate the possible benefits as well as side effects of TRF and to develop a structured implementation schema to ensure adherence and success.

## Declarations

### **Ethics, consent and permissions**

The study protocol was approved by the ethics committee of Ulm University in May 2018 (Application No. 153/18). The TRF Pilot Study is registered at the German Clinical Trials Register (DRKS) under the DRKS-ID: DRKS00015057. Written informed consent was obtained from all participants.

### **Consent for publication**

Not applicable.

### **Availability of data and materials statement**

The datasets generated and analysed during the current study are not publicly available due to reasons of data protection but are available from the responsible data manager, Prof. Dr. Tibor Kesztyüs, on reasonable request.

### **Competing Interests**

The authors declare that they have no competing interests.



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This research was conducted without any funding.

## Authors' contributions

DK planned and organised the study, performed the statistical analysis and drafted the manuscript. TK was responsible for the data management. DS prepared the initial and final examination and was significantly involved in their implementation. MG supervised the examinations. TK and MG revised the manuscript drafts.

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## References

1. Schienkiewitz A, Gert B, Mensink M, Kuhnert R, Lange C. Overweight and obesity among adults in Germany. 2017;20–7.
2. Looney SM, Raynor HA. Behavioral Lifestyle Intervention in the Treatment of Obesity. Heal Serv Insights. 2013;6:15–31.
3. Montesi L, Ghoch M El, Brodosi L, Calugi S, Marchesini G, Grave RD. Long-term weight loss maintenance for obesity : a multidisciplinary approach. 2016;37–46.
4. Francesco A Di, Germanio C Di, Bernier M, Cabo R De. A time to fast. 2018;775(November):770–5.
5. Brandhorst S, Choi IY, Wei M, Morgan TE, Dorff TB, Longo VD, et al. Clinical and Translational Report A Periodic Diet that Mimics Fasting Promotes Multi- System Regeneration , Enhanced Cognitive Clinical and Translational Report A Periodic Diet that Mimics Fasting Promotes Multi-System Regeneration. Cell Metab. 2015;22(1):86–99.
6. Sainsbury A, Wood RE, Seimon R V, Hills AP, King NA, Gibson AA, et al. Rationale for novel intermittent dieting strategies to attenuate adaptive responses to energy restriction. 2018;19(December):47–60.
7. World Health Organization (WHO). Waist circumference and Waist- hip Ratio: Report of a WHO Expert Consultation [Internet]. 2008. Available from: [https://www.who.int/nutrition/publications/obesity/WHO\\_report\\_waistcircumference\\_and\\_waisthip\\_ratio/en/](https://www.who.int/nutrition/publications/obesity/WHO_report_waistcircumference_and_waisthip_ratio/en/)
8. Barton GR, Sach TH, Doherty M, Avery AJ, Jenkinson C, Muir KR. An assessment of the discriminative ability of the EQ-5Dindex, SF-6D, and EQ VAS, using sociodemographic factors and clinical conditions. Eur J Heal Econ. 2008;9(3):237–49.
9. Chaix A, Zarrinpar A, Miu P, Panda S. Time-restricted feeding is a preventative and therapeutic intervention against diverse nutritional challenges. Cell Metab. 2014;20(6):991–1005.
10. Mielck A, Vogelmann M, Leidl R, Mielck A, Reitmeir P, Vogelmann M, et al. Health-related quality of life and socioeconomic status: inequalities among adults with a chronic disease. Health Qual Life Outcomes. 2014;12(1):58.

11. World Health Organization (WHO). Health statistics and information systems [Internet]. WHOQOL: Measuring Quality of Life. 2019 [cited 2019 Jun 12]. Available from: <https://www.who.int/healthinfo/survey/whoqol-qualityoflife/en/>
12. Gill S, Panda S. A Smartphone App Reveals Erratic Diurnal Eating Patterns in Humans that Can Be Modulated for Health Benefits. *Cell Metab.* 2015;22(5):789–98.
13. Kesztyüs D, Erhardt J, Schönsteiner D, Kesztyüs T. Treatment options for abdominal obesity in adults - a meta-analysis and systematic review of randomized controlled trials. *Dtsch Arztebl Int.* 2018;115(in press).
14. Gabel K, Hoddy K, Haggerty N, Song J, Kroeger C, Trepanowski JF, et al. Effects of 8-hour time restricted feeding on body weight and metabolic disease risk factors in obese adults: A pilot study. *Nutr Heal Aging.* 2018;4:345–53.
15. Gasmi M, Sellami M, Denham J, Padulo J, Kuvacic G, Selmi W, et al. Time-restricted feeding influences immune responses without compromising muscle performance in older men. *Nutrition.* 2018;51–52:29–37.
16. Moro T, Tinsley G, Bianco A, Marcolin G, Pacelli QF, Battaglia G, et al. Effects of eight weeks of time-restricted feeding (16/8) on basal metabolism, maximal strength, body composition, inflammation, and cardiovascular risk factors in resistance-trained males. *J Transl Med.* 2016;14(1):1–10.
17. leangains. The Leangains Guide [Internet]. [cited 2019 Jun 4]. Available from: <https://leangains.com/the-leangains-guide/>
18. Sutton EF, Beyl R, Early KS, Cefalu WT, Ravussin E, Peterson CM. Early Time-Restricted Feeding Improves Insulin Sensitivity, Blood Pressure, and Oxidative Stress Even without Weight Loss in Men with Prediabetes. *Cell Metab.* 2018;27(6):1212-1221.e3.
19. Vaughan KL, Mattison JA. Watch the Clock, Not the Scale. *Cell Metab.* 2018;27(6):1159–60.
20. Patterson RE, Laughlin GA, Sears DD, LaCroix AZ, Marinac C, Gallo LC, et al. Intermittent Fasting and Human Metabolic Health. *J Acad Nutr Diet.* 2015;115(8):1203–12.

## Tables

**Table 1** Baseline characteristics of participants in the TRF pilot study 2018

	Female (n=54)	Male (n=9)	Total (n=63)
Age, years m (sd)	47.8 (10.1)	47.9 (13.5)	47.8 (10.5)
Weight, kg m (sd)	71.7 (12.5) <sup>1</sup>	87.3 (16.1)	73.9 (14.1)
Waist circumference, cm m (sd)	87.6 (11.3) <sup>2</sup>	98.4 (12.8)	89.1 (12.0)
BMI, kg/m <sup>2</sup> m (sd)	25.9 (4.8)	27.5 (3.5)	26.1 (4.6)
WHtR, m (sd)	0.53 (0.07)	0.54 (0.07)	0.53 (0.07)
Overweight, n (%)	15 (27.8)	5 (55.6)	20 (31.7)
Obesity, n (%)	9 (16.7)	2 (22.2)	11 (17.5)
Abdominal obesity, n (%)	29 (53.7)	7 (77.8)	36 (57.1)
LDL, mmol/l m (sd)	3.46 (0.88)	3.60 (0.96)	3.48 (0.89)
HDL, mmol/l m (sd)	1.80 (0.38) <sup>3</sup>	1.40 (0.21)	1.74 (0.39)
TCHOL, mmol/l m (sd)	5.24 (0.86)	5.22 (1.09)	5.32 (0.89)
Triglycerides, mmol/l m (sd)	1.23 (0.58) <sup>4</sup>	1.79 (0.92)	1.31 (0.66)
LDL/HDL, m (sd)	2.04 (0.76)	2.63 (0.84)	2.12 (0.79)
Triglycerides/HDL, m (sd)	0.75 (0.47) <sup>5</sup>	1.39 (0.98)	0.84 (0.60)
HRQoL, m (sd)*	74.6 (13.8)	73.9 (12.7)	74.5 (13.5)
Daily eating time, m (sd)**	12.19 (1.73) <sup>6</sup>	13.78 (2.25)	12.42 (1.88)

NOTE. m mean, sd standard deviation, BMI body mass index, WHtR waist-to-height ratio, HRQoL health-related quality of life

\* 10 missing values, \*\* 1 missing value

<sup>1</sup>p=0.005, <sup>2</sup>p=0.009, <sup>3</sup>p=0.004, <sup>4</sup>p=0.047, <sup>5</sup>p=0.014, <sup>6</sup>p=0.018

**Table 2** Follow-Up results of participants in the TRF pilot study 2018

	Female (n=53)	Male (n=8)	Total (n=61)
Weight, kg m (sd)	70.9 (12.63) <sup>1</sup>	87.0 (15.66)	72.6 (14.1)
Waist circumference, cm m (sd)	86.0 (11.39) <sup>2</sup>	97.1 (12.49)	87.4 (12.0)
BMI, kg/m <sup>2</sup> m (sd)	25.4 (4.76)	27.0 (3.70)	25.6 (4.6)
WHtR, m (sd)	0.52 (0.074)	0.54 (0.065)	0.52 (0.073)
Overweight, n (%)	13 (24.5)	5 (62.5)	18 (29.5)
Obesity, n (%)	10 (18.9)	1 (12.5)	11 (18.0)
Abdominal obesity, n (%)	29 (54.7)	7 (87.5)	36 (59.0)
LDL, mmol/l m (sd)	3.57 (0.88)	3.69 (0.88)	3.59 (0.88)
HDL, mmol/l m (sd)	1.80 (0.41) <sup>3</sup>	1.40 (0.21)	1.75 (0.41)
TCHOL, mmol/l m (sd)	5.73 (0.93)	5.64 (0.87)	5.72 (0.91)
Triglycerides, mmol/l m (sd)	1.28 (0.65) <sup>4</sup>	2.35 (0.54)	1.41 (0.73)
LDL/HDL, m (sd)	2.12 (0.80)	2.70 (0.80)	2.20 (0.82)
Triglycerides/HDL, m (sd)	0.80 (0.56) <sup>4</sup>	1.72 (0.54)	0.92 (0.64)
HRQoL, m (sd)*	80.3 (11.3)	79.1 (9.1)	80.2 (11.0)
Δ Weight, kg m (sd)	-1.16 (2.33)	-2.23 (2.27)	-1.3 (2.33) <sup>a1</sup>
Δ Waist circumference, cm m (sd)	-1.55 (3.18)	-2.79 (3.47)	-1.7 (3.22) <sup>a1</sup>
Δ BMI, m (sd)	-0.41 (0.84)	-0.70 (0.72)	-0.45 (0.83) <sup>a1</sup>
Δ WHtR, m (sd)	-0.01 (0.019)	-0.02 (0.020)	-0.01 (0.019) <sup>a1</sup>
Δ LDL, mmol/l m (sd)	0.08 (0.50)	-0.10 (0.32)	0.06 (0.48)
Δ HDL, mmol/l m (sd)	-0.01 (0.16)	0.00 (0.11)	0.00 (0.15)
Δ TCHOL, mmol/l m (sd)	0.37 (0.53)	0.19 (0.34)	0.34 (0.51) <sup>a1</sup>
Δ Triglycerides, mmol/l m (sd)	0.04 (0.47)	0.41 (0.80)	0.09 (0.53)
Δ HRQoL, m (sd)**	6.0 (13.2)	4.8 (7.3)	5.8 (12.4) <sup>a2</sup>

NOTE. m mean, sd standard deviation, BMI body mass index, WHtR waist-to-height ratio, HRQoL health-related quality of life

\* 2 missing values, \*\* 11 missing values

<sup>1</sup>p=0.007, <sup>2</sup>p=0.011, <sup>3</sup>p=0.009, <sup>4</sup>p=0.000

<sup>a</sup> significance of differences between baseline and follow-up, <sup>a1</sup>p<0.001, <sup>a2</sup>p=0.008

**Table 3** Diary of participants in the TRF pilot study 2018

	Female (n=53)	Male (n=8)	Total (n=61)
Sleep duration, h m (sd)	7.39 (0.55)	7.37 (0.70)	7.38 (0.56)
Sleep quality, m (sd)	73.4 (14.6)	71.6 (10.1)	73.2 (14.0)
Time of first meal, m (sd)	10.47 (1.32)	10.01 (1.14)	10.41 (1.30)
Time of last meal, m (sd)	18.81 (1.02)	18.51 (0.89)	18.77 (1.00)
Eating phase, h m (sd)	8.36 (0.89)	8.50 (1.08)	8.38 (0.91)
Fasting phase, h m (sd)	15.69 (0.92)	15.48 (1.07)	15.66 (0.93)
Fasting target reached, %	72.8 (18.8)	68.1 (20.3)	72.2 (18.9)

NOTE. m mean, sd standard deviation

## Figures

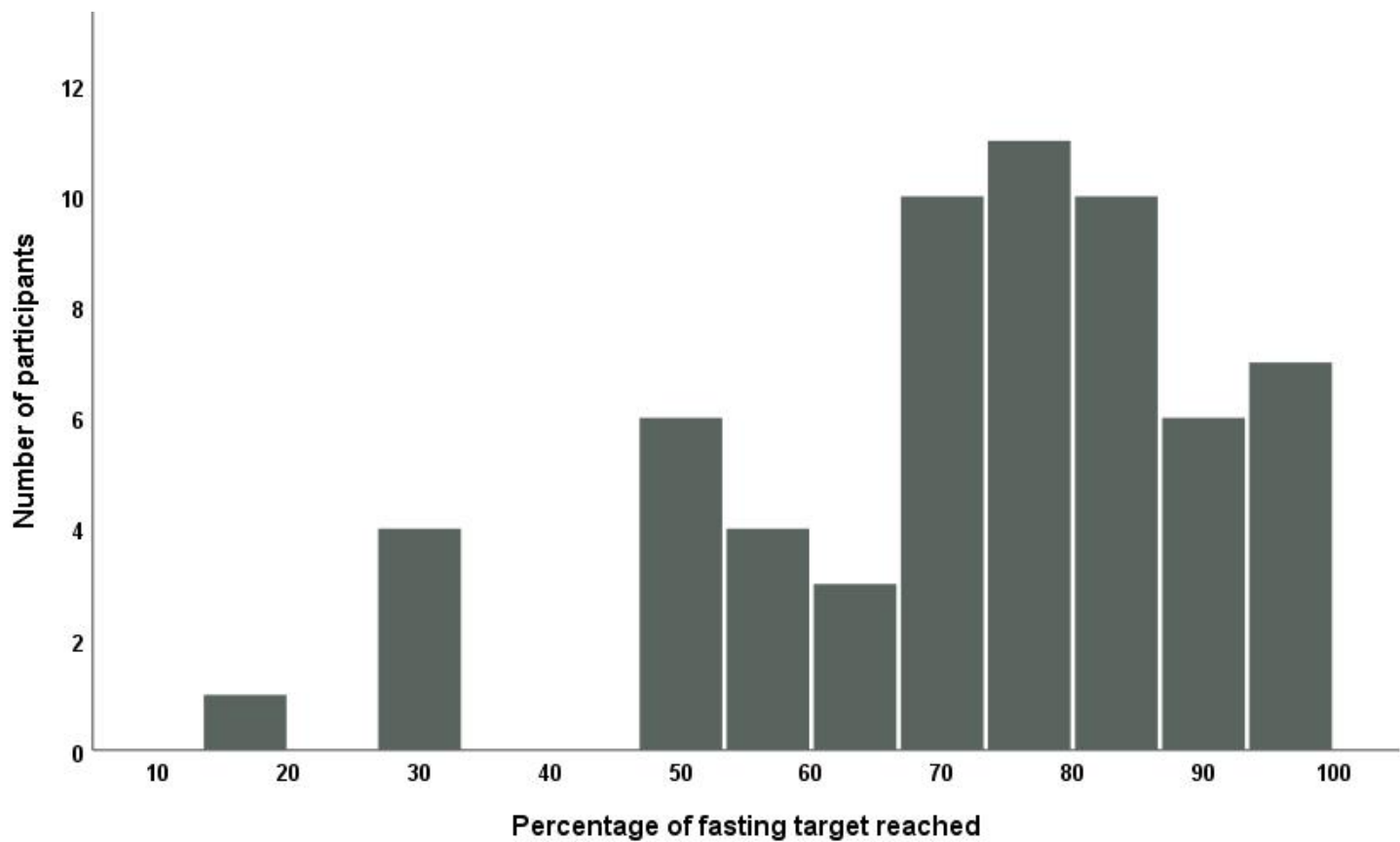
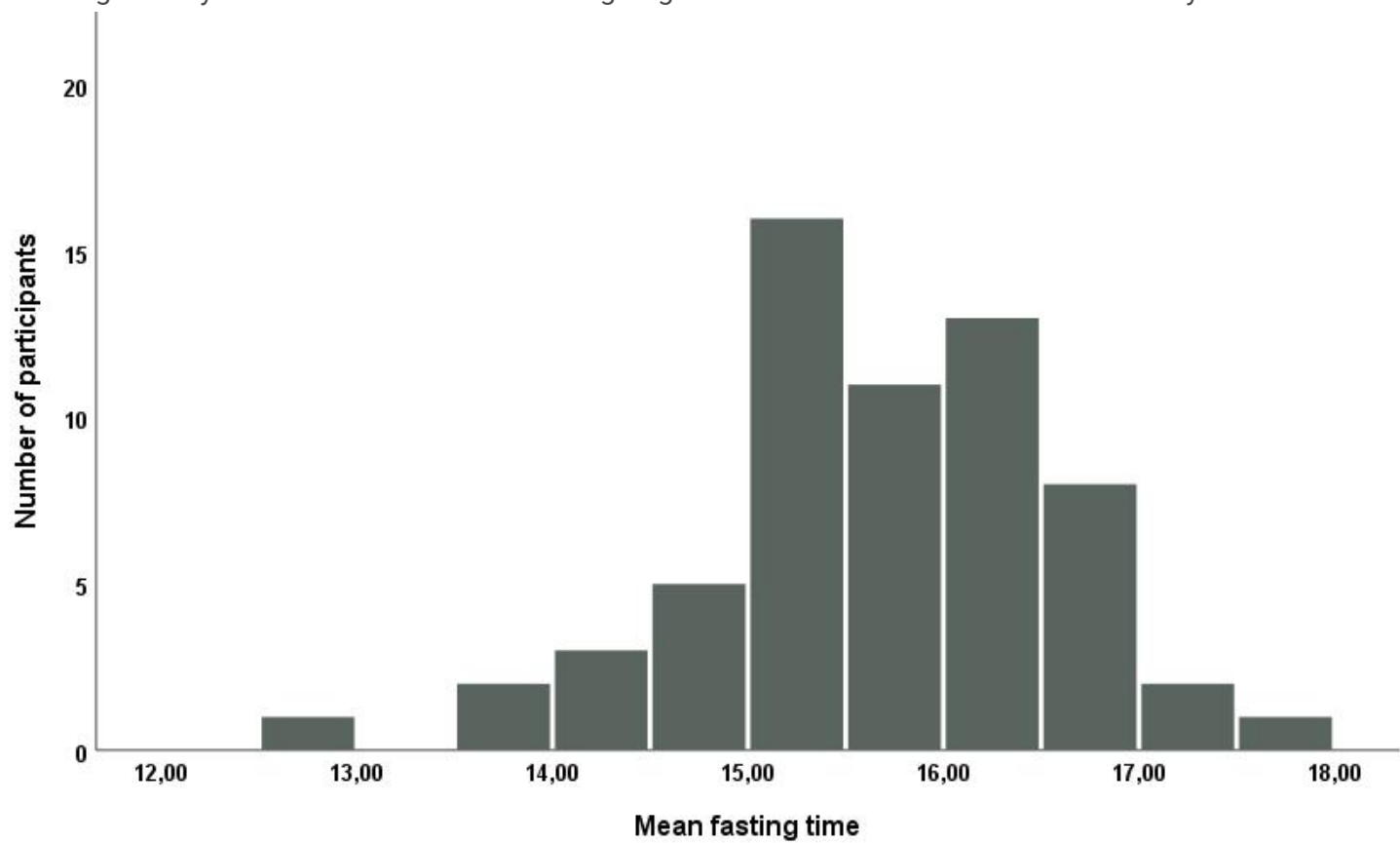


Figure 1

Percentage of days with attainment of the fasting target in the total number of documented days.



**Figure 2**

Mean fasting time of participants during the study course.

