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Effectiveness of the MetSLIM lifestyle intervention targeting individuals of low socio-economic status and different ethnic origins with elevated waist-to-height ratio

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Abstract
Objective: To evaluate whether the lifestyle intervention MetSLIM targeting individuals of low socio-economic status of Turkish, Moroccan and Dutch origin was successful in improving waist circumference and other cardiometabolic risk factors, lifestyle behaviour and quality of life.
Design: A quasi-experimental intervention study (Netherlands Trial Register NTR3721). The intervention group participated in a 12-month combined dietary and physical activity programme. Examinations were performed at baseline and after 12 months. Participants underwent anthropometric measurements and blood withdrawal, and completed questionnaires on dietary intake, physical activity and quality of life.
Setting: Socio-economically deprived neighbourhoods in two Dutch cities, involving non-blinded ethnicity-matched and gender-matched research assistants, dietitians and sports instructors.
Subjects: Mainly Turkish (49 %) and Dutch (36 %) subjects, aged 30–70 years, with a waist-to-height ratio of >0·5 (intervention, *n* 117; control, *n* 103). Dropout was 31 %.
Results: At 12 months, the intervention group showed greater improvements than the control group in waist circumference ($\beta = -3·3$ cm, 95 % CI –4·7, –1·8, $P < 0·001$) and other obesity measures. Additionally, greater reductions were observed for total cholesterol ($\beta = -0·33$ mmol/l, 95 % CI –0·56, –0·10, $P = 0·005$) and LDL cholesterol ($\beta = -0·35$ mmol/l, 95 % CI –0·56, –0·14, $P = 0·001$). Dietary changes were significant for fibre intake ($\beta = 1·5$ g/4184 kJ (1000 kcal), 95 % CI 0·3, 2·7, $P = 0·016$). Compared with the control group, the intervention group reported a decrease in total minutes of physical activity ($\beta = -573$ min/week, 95 % CI –1126, –21, $P = 0·042$) and showed improvements in the quality-of-life domains 'health transition' and 'general health'.
Conclusions: MetSLIM was shown to be effective in improving waist circumference, total and LDL cholesterol, and quality of life among Dutch and Turkish individuals living in deprived neighbourhoods.

Keywords
Effectiveness
Lifestyle intervention
Health promotion
Socio-economic status
Ethnic groups

Lifestyle intervention studies such as the Diabetes Prevention Program (DPP) and the Diabetes Prevention Study have shown that lifestyle interventions have beneficial effects on risk factors for cardiometabolic diseases and reduce the development of type 2 diabetes mellitus[1–3]. The success of these studies has led to the adaptation of these lifestyle interventions towards several different target groups and settings[4–9].

In the Netherlands, the Study of Lifestyle intervention and Impaired glucose tolerance Maastricht (SLIM) also showed that a combined diet and physical activity intervention reduces diabetes risk[10]. The SLIM study was a randomised controlled trial studying the effectiveness of a lifestyle intervention on glucose tolerance in persons with impaired

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glucose tolerance. Participants in the lifestyle intervention received 1 h of individual dietary advice every 3 months and one group session per year, lasting 90 min, led by a dietitian. In addition, they could participate in a weekly supervised aerobic and resistance training programme at the university fitness centre[11]. In that trial, individuals with low socio-economic status (SES) were more likely to drop out than individuals with higher SES[12]. This is unfortunate, as in general the prevalence of CVD and type 2 diabetes mellitus is relatively high among individuals with low SES[13]. Others have also shown that this group is less likely to participate in lifestyle interventions and more likely to drop out early[14–16]. Similar patterns, with respect to both the higher prevalence of cardiometabolic diseases and the high dropout rates, have been observed in ethnic minorities living in the Netherlands[17–20]. Therefore, this group forms an important target group for lifestyle interventions.

In order to tackle the under-representation of socio-economically disadvantaged individuals and ethnic minorities in health promotion activities, adapted methods are necessary to reach and retain this group effectively[21–23]. For this reason, we adapted the SLIM study to the needs and preferences of low-SES individuals of Dutch, Turkish and Moroccan origin (the three largest ethnic groups in the Netherlands) based on the findings of preceding research[22,24,25]. This adapted study was named MetSLIM.

Following the preferences of the target group, adaptations included additional group meetings about topics relevant for the target group; involving ethnicity- and gender-matched research assistants, dietitians and sports instructors; activities provided for women and men separately; and all activities provided in participants' own neighbourhood. Study design, setting and measurements were chosen to minimise the burden of participation. A detailed overview of the choices and considerations in the adaptation process from SLIM to MetSLIM is described elsewhere[25]. The aim of the present study was to evaluate whether the adapted lifestyle intervention was successful in improving waist circumference and other cardiometabolic risk factors, lifestyle behaviour and quality of life among low-SES individuals of Dutch, Turkish and Moroccan origin.

Methods

Study design

MetSLIM was a quasi-experimental study running from January 2013 until June 2015 in two cities in the Netherlands. Participants were invited to either the intervention group or the control group. Measurements were not taken blinded; researchers knew which group the participants belonged to. Participants were blinded to the study design; participants knew that the effect of the programme was being evaluated, however, they were not aware of the existence of a comparison group receiving a different programme. All participants gave their written informed consent before the start of the study. The design of the MetSLIM study has been published in more detail previously[25].

Recruitment

Individuals of Dutch, Turkish and Moroccan origin, aged 30–70 years, were recruited in socio-economically deprived neighbourhoods. Intervention group participants were recruited in different neighbourhoods from control group participants to avoid dissatisfaction and spill-over. The aim was to achieve similar numbers of participants for each ethnicity (frequency matching) in the intervention and control groups. Two recruitment strategies were used. First, participants were recruited via general practices that either were situated in socio-economically deprived neighbourhoods or had a broad spectrum of low-SES patients or ethnic minority patients. General practitioners made a selection of potential participants in their database based on the inclusion criteria that were available in their registry, such as age, medication use and postal code (as an indicator for neighbourhood). General practitioners were asked to select only patients from Dutch, Turkish and Moroccan origin who were physically and mentally able to participate in the intervention. Second, participants were recruited in community centres involving community health workers (e.g. social workers), local health professionals and other local contacts. Interested persons were asked to fill out a screening questionnaire to check whether they fulfilled the inclusion or the exclusion criteria.

The inclusion criteria were: (i) waist-to-height ratio (WHtR) >0·5; (ii) aged between 30 and 70 years; (iii) no medication for hypertension, hypercholesterolaemia, CVD, diabetes mellitus or/and renal failure at baseline; (iv) living in a socio-economically deprived neighbourhood; and (v) Dutch, Turkish or Moroccan ethnic origin. Following the definitions of Statistics Netherlands, persons with both parents born in the Netherlands are considered to be Dutch[26] and persons who have at least one parent born in Morocco/Turkey are considered to be Moroccan/Turkish[27]. However, if persons signed up for the study from neighbourhoods close by or of another ethnic background, they were also accepted for participation in the study as it was considered unethical and undesirable (for social cohesion) to exclude them. Exclusion criteria were: (i) having a mental or physical disability that made participation in a lifestyle intervention impossible; (ii) already participating in a lifestyle programme targeting weight loss; and (iii) pregnant or lactating.

Based on the results of the screening questionnaire, eligible participants were invited for baseline measurements. The appointment for baseline measurements took place at a community or health-care centre in participants' own neighbourhood. At the beginning of this appointment, participants gave written informed consent. At the end of the appointment, participants received a referral letter to the medical laboratory for blood withdrawal and instructions for the start of the intervention or control programme. During the inclusion period (January 2013 to June 2014), 220 participants with elevated WHtR enrolled in the study, of whom 117 participated in the intervention group and 103 in the control group.

Intervention and control groups

The intervention group participated in a 12-month lifestyle intervention that promoted lifestyle change and weight loss through increased physical activity and changes in dietary habits following the general Dutch public health recommendations[28] (see the online supplementary material, Supplemental File 1). The lifestyle intervention was provided in a community setting and consisted of three components: four group meetings, 4 h of individual dietary advice and weekly sports lessons. All group meetings on nutrition were provided separately for Dutch, Turkish and Moroccan participants. The individual dietary advice (maximum 4 h) was divided over a flexible number of consultations and was given by a dietitian who was ethnicity-matched to the Dutch, Turkish and Moroccan participants. Dietitians tailored their advice, based on the national guidelines on healthy nutrition[28], to the needs of each participant. Additionally, participants were invited to join the four group meetings (90 min). The first was an introductory meeting, guided by the researcher, in which participants got to know the dietitian, the sports instructor and other study participants. The other three group meetings were about nutrition and were guided by the dietitian. The group meeting focused on label reading, social occasions and price concerns (supermarket tour). Because of a lack of interest or other thematic priorities, the meeting on price concerns was in some cases replaced by a meeting about 'Staying motivated' or 'Ramadan'. The dietary advice and the group meetings were, if preferred, given in participants' native language. The physical activity lessons (60 min) were set up especially for the study participants and were tailored to the needs and preferences of the sports groups. Sports instructors provided a variety of activities such as basketball, circuit training, core stability, zumba and walking. The physical activity classes for ethnicities other than Dutch were provided separately for women and men with gender-matched sports instructors. Participants were allowed to bring friends and family along to the physical activity lessons if that was feasible given the space of the physical activity location.

The participants in the control group received only one group meeting (90 min) guided by a dietitian, together with, if necessary, a language assistant with a dietetic background. The dietitian provided the group with general information about a healthy diet. Additionally, participants received information leaflets on the benefits of healthy nutrition and increased physical activity.

The intervention programme was promoted as 'TogetherLongerHealthy' and the control programme as 'Health check'. Both groups participated in the same measurements. All participants received the results of their own measurements. Measurement results were also sent to the general practitioners.

Outcome measures

To evaluate the effectiveness of the lifestyle intervention programme, data were collected at baseline and after 12 months. Participants underwent physical examinations and were asked to fill in questionnaires, either alone or together with a research assistant speaking their native language. Standardised measurement procedures were followed, which were described in protocols. Height was measured without shoes to the nearest millimetre. Body weight and body fat percentage were measured with a Tanita BC-418 bioimpedance scale (Tanita Corporation, Tokyo, Japan). Waist circumference was determined midway between the lowest rib and the iliac crest, and hip circumference was measured at the widest portion of the buttocks. Both were measured twice to the nearest 0·5 cm and averaged. Blood pressure was measured six times (with 2 min of rest in between) in a seated position with an Omron 705CP (Omron Healthcare Co., Kyoto, Japan). The mean was calculated from the last five measurements. Blood samples were taken after at least 10 h of fasting to measure fasting glucose, HDL cholesterol, total cholesterol, TAG, HbA1c (glycated Hb), fasting insulin, liver function enzymes, creatinine and uric acid. A fasting spot urine sample was collected to measure albumin and creatinine. Analyses were performed at either SHO laboratory in Velp or Maxima Medisch Centrum laboratory in Veldhoven, the Netherlands, depending on the location of the blood sampling. For fasting insulin, all blood samples were analysed at SHO laboratory in Velp.

Albuminuria was determined by the ratio between urinary concentrations of albumin and creatinine, with a cut-off of >2·5 mg/mmol for men and >3·5 mg/mmol for women[29]. LDL cholesterol was calculated using the Friedewald formula[30]. Metabolic syndrome was defined by the revised National Cholesterol Education Program Adult Treatment Panel III criteria as the presence of three or more of the following five cardiometabolic risk factors: (i) increased waist circumference (men ≥102 cm, women ≥88 cm); (ii) low HDL cholesterol (men <1·03 mmol/l, women <1·29 mmol/l or on drug treatment for reduced HDL cholesterol); (iii) high TAG level (≥1·69 mmol/l or on drug treatment for elevated TAG); (iv) increased blood pressure (systolic ≥130 mmHg and/or diastolic ≥85 mmHg or on antihypertensive drug treatment); and (v) impaired fasting glucose (≥5·6 mmol/l or on drug treatment for elevated glucose)[31]. For participants with both parents born in Asia (except for countries in the Middle East), cut-off values of 90 cm (men) and 80 cm (women) for waist circumference were used[31].

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Physical activity was measured with the Short Questionnaire to Assess Health-enhancing physical activity (SQUASH)[32]. Dietary intake was assessed with ethnic-specific FFQ[33] and calculated using the 2013 Dutch food composition database[34]. Adherence to a healthy diet was assessed by the Dutch Healthy Diet index (DHD-index)[35,36]. The original DHD-index consists of ten components, representing the Dutch Guidelines for a Healthy Diet[28]. Eight of the ten components were measured in the MetSLIM study (physical activity, vegetables, fruit, fibre, fish, SFA, *trans*-fatty acids and alcohol). Participants could score between 0 and 10 points, resulting in a total maximum score of 80 points. A higher score represents better adherence to the Dutch Guidelines for a Healthy Diet. Quality of life was assessed in different health domains with the 36-Item Short Form Health Survey (SF-36) questionnaire[37].

Statistical analysis

It was calculated that a sample size of 252 participants would be required to detect a change in waist circumference of 1·1 cm, assuming α of 0·05, power of 80 % and a dropout rate of 25 %[25]. Eventually, 220 participants could be enrolled in the MetSLIM study during an intensive recruitment period of 17 months (see Fig. 1).

Participants who became pregnant during the study (*n* 5) were excluded from the analyses. Furthermore, participants with missing data on waist circumference (the primary outcome measure) at 12 months were considered dropouts and excluded from the analyses; these participants missed data on the other measures as well (*n* 66). As a result, data collected from 149 participants were used for statistical analysis. Participants with a C-reactive protein concentration >10 mg/l were excluded from the analysis regarding C-reactive protein, because these concentrations reflect acute rather than chronic inflammation[38,39]. Participants who skipped whole sections of the FFQ or reported a consumption of less than 2092 kJ/d (500 kcal/d) or 3347 kJ/d (800 kcal/d), for women and men respectively, were excluded from the analyses for dietary intake (*n* 5)[40]. Excessive alcohol consumption was classified as more than 21 consumptions/week for men and more than 14 consumptions/week for women.

Data were analysed with the statistical software package IBM SPSS Statistics version 22. Significance level was set at 0·05. All analyses were performed according to the intention-to-treat principle, where participants were analysed in the groups for which they were recruited, regardless of whether they actively participated in that group. Continuous variables are presented as mean and SD, and categorical variables as number and percentage. Baseline characteristics were compared between participants in the intervention and the control group, and between completers and dropouts, with χ^2 tests, independent-samples *t* tests or Mann–Whitney tests. For each outcome variable, baseline results are described for those participants who had data for that variable at baseline and after 12 months. Changes in prevalence of metabolic syndrome and albuminuria were compared within the intervention and the control group with McNemar's tests. Changes in continuous effect outcomes over time were compared between the intervention and the control group by ANCOVA, with change after 12 months as the outcome variable, adjusted for the mean value of the measurements at baseline and 12 months for the respective variable[41] and ethnicity. Although general practitioners and researchers screened for relevant medication during recruitment, a few medication users were enrolled in the study. Excluding users of medication for glucose (*n* 2), cholesterol (*n* 5) or blood pressure (*n* 2) from those analyses that could be influenced by medication use resulted in similar results, except for HbA1c. Medication users were therefore included in the analyses.

The effect of the treatment was compared between participants of Dutch and Turkish origin (the two largest ethnic groups in the study). To test the interaction between treatment and ethnicity, an interaction term was added to the model. For the interaction term between treatment and ethnicity, a *P* value of 0·20 was considered relevant[42]. The effect of the treatment on dietary intake was not compared between Dutch and Turkish participants, because dietary intake was known for only a small number of Turkish participants in the control group (*n* 6).

Results

Baseline characteristics and programme attendance

Participants who dropped out (*n* 66, 31 %) did not differ in baseline characteristics from the completers, except that they were more often smokers and had more often been recruited via their general practitioner (Table 1). The most important reasons for dropout were lack of time (30 %), lack of interest (26 %) and lost contact (20 %; Fig. 1).

Completers attended more often the introduction meeting of the intervention programme (76 *v.* 51 %) and more often one or more of the three dietary group meetings than dropouts (85 *v.* 29 %). Completers also made more use of the individual dietary advice (155 (SD 52) *v.* 53 (SD 54) min). Participation in physical activity lessons was unfortunately incompletely registered by sport instructors; however, the lessons that were registered showed higher attendance among completers compared with dropouts in the physical activity lessons as well.

The baseline characteristics of the 149 participants who completed the study are presented in Table 2. In general, baseline characteristics were similar between the intervention and the control group. On average, the completing participants were 47·5 (SD 9·2) years old. Most of them were of Dutch (40 %) or Turkish origin (48 %) and female (83 %).

Table 1 Comparison of baseline characteristics between completers and dropouts in the MetSLIM study targeting individuals of low socio-economic status and different ethnic origins with elevated waist-to-height ratio, the Netherlands, January 2013–June 2015

	Completers (*n* 149)*		Dropouts (*n* 66)*		
	n or Mean†	% or SD†	*n* or Mean†	% or SD†	*P*‡
Treatment group					0·93
Intervention group	80	54	35	53	
Control group	69	46	31	47	
Recruitment strategy					0·047
Invited by general practitioner	73	49	42	64	
Invited in community centre	76	51	24	36	
Gender					0·13
Male	25	17	17	26	
Female	124	83	49	74	
Age (years)	47·5	9·2	45·4	10·1	0·14
Ethnicity					0·17
Dutch	59	40	20	30	
Turkish	71	48	35	53	
Moroccan	6	4	7	11	
Other	13	9	4	6	
Educational level					0·18
No education	16	11	14	21	
Lowest education (primary)	41	28	15	23	
Low education (lower secondary)	35	23	19	29	
Middle education	38	26	13	20	
High education	19	13	5	8	
Employment status					0·47
No paid job	83	56	37	64	
Part-time job (<32 h/week)	40	27	11	19	
Full-time job (≥32 h/week)	25	17	10	17	
Household situation					0·19
Single occupant	30	20	10	18	
Living with partner	27	18	12	21	
Living with partner and child(ren)	67	46	32	56	
Single parent living with child(ren)	23	16	3	5	
Smoking status					0·031
Current	30	20	22	38	
Former	39	26	11	19	
Never	79	53	25	43	
Alcohol consumption					0·22
No consumption	76	60	39	74	
Low to moderate consumption	42	33	11	21	
Excessive consumption	8	6	3	6	
Metabolic syndrome					0·60
No	102	72	37	69	
Yes	39	28	17	31	
Family history of type 2 diabetes in first-degree relative					0·88
No	89	61	36	62	
Yes	57	39	22	38	

*Employment status: completer *n* 148, dropout *n* 58; household situation: completer *n* 147, dropout *n* 57; smoking status: completer *n* 148, dropout *n* 58; alcohol consumption: completer *n* 126, dropout *n* 53; metabolic syndrome: completer *n* 141, dropout *n* 54; family history of type 2 diabetes in first-degree relative: completer *n* 146, dropout *n* 58.
†Data are expressed as *n* and % for categorical variables; or mean and SD for continuous variables.
‡*P* value of χ^2 tests or independent-samples *t* tests.

Thirty-eight per cent of them had completed no education or primary school only, and 56 % had no paid job. The latter were mostly househusband/housewife (35 %), disabled (18 %) or unemployed/looking for a job (15 %).

Intervention effects on cardiometabolic risk factors

After 12 months, beneficial intervention effects were observed for cardiometabolic risk factors (Table 3). Mean difference in change in waist circumference was −3·3 cm (95 % CI −4·7, −1·8) between the two groups. Also, greater reductions were observed in weight ($\beta = -2{\cdot}2$ kg, 95 % CI −3·7, −0·8), BMI ($\beta = -0{\cdot}8$ kg/m^2, 95 % CI −1·3, −0·3), WHtR ($\beta = -0{\cdot}020$, 95 % CI −0·028, −0·011) and fat percentage ($\beta = -0{\cdot}9$ %, 95 % CI −1·8, −0·1) in the intervention group compared with the control group.

Apart from waist circumference, no significant improvements were observed for other components of the metabolic syndrome. Metabolic syndrome prevalence did not change significantly in either the intervention group (from 18/68 to 18/68 after 12 months; $P = 1{\cdot}00$) or the control group (from 16/60 to 20/60 after 12 months; $P = 0{\cdot}29$). The intervention group had greater improvements in total cholesterol ($\beta = -0{\cdot}33$ mmol/l, 95 % CI −0·56, −0·10) and LDL cholesterol ($\beta = -0{\cdot}35$ mmol/l, 95 % CI −0·56, −0·14) compared with the control group. Albuminuria was rare in both the intervention group (from 1/73 to 3/73 after 12 months; $P = 0{\cdot}50$) and the control group (from 1/58 to 2/58 after 12 months; $P = 1{\cdot}00$).

Intervention effects on dietary intake and physical activity

After 12 months, the intervention group reported an increased fibre intake compared with the control group ($\beta = 1{\cdot}5$ g/4184 kJ (1000 kcal), 95 % CI 0·3, 2·7; Table 4). The intervention group also reported a reduction in energy intake ($\beta = -1359$ kJ, 95 % CI −3082, 363 ($\beta = -325$ kcal, 95 % CI −736, 87), $P = 0{\cdot}12$). Additionally, the intervention group reported a decrease in total minutes of physical activity compared with the control group ($\beta = -573$ min/week, 95 % CI −1126, −21).

Intervention effects on quality of life

The intervention group after 12 months showed greater improvement in the domains 'health transition' (i.e. self-rated health compared with 1 year ago) and 'general health' (i.e. their own self-reported health and their self-rated health compared with that of others) compared with the control group ($P < 0{\cdot}001$). Other changes within domains of quality of life were not different between the groups (Table 5).

Intervention effects among different ethnic groups

In general, the intervention effects were more beneficial among participants of Dutch origin than among participants of Turkish origin, especially for the different measures of obesity (see online supplementary material, Supplemental Tables 1 to 3). Intervention effect on waist circumference (P for interaction $= 0{\cdot}14$) among participants of Dutch origin was −4·8 cm (95 % CI −7·7, −2·0) compared with −2·7 cm (95 % CI −4·2, −1·2) among participants of Turkish origin. For total physical activity (P for interaction $= 0{\cdot}018$) and light-intensity physical activity (P for interaction $= 0{\cdot}006$), the intervention effect was disadvantageous for participants of Turkish origin only

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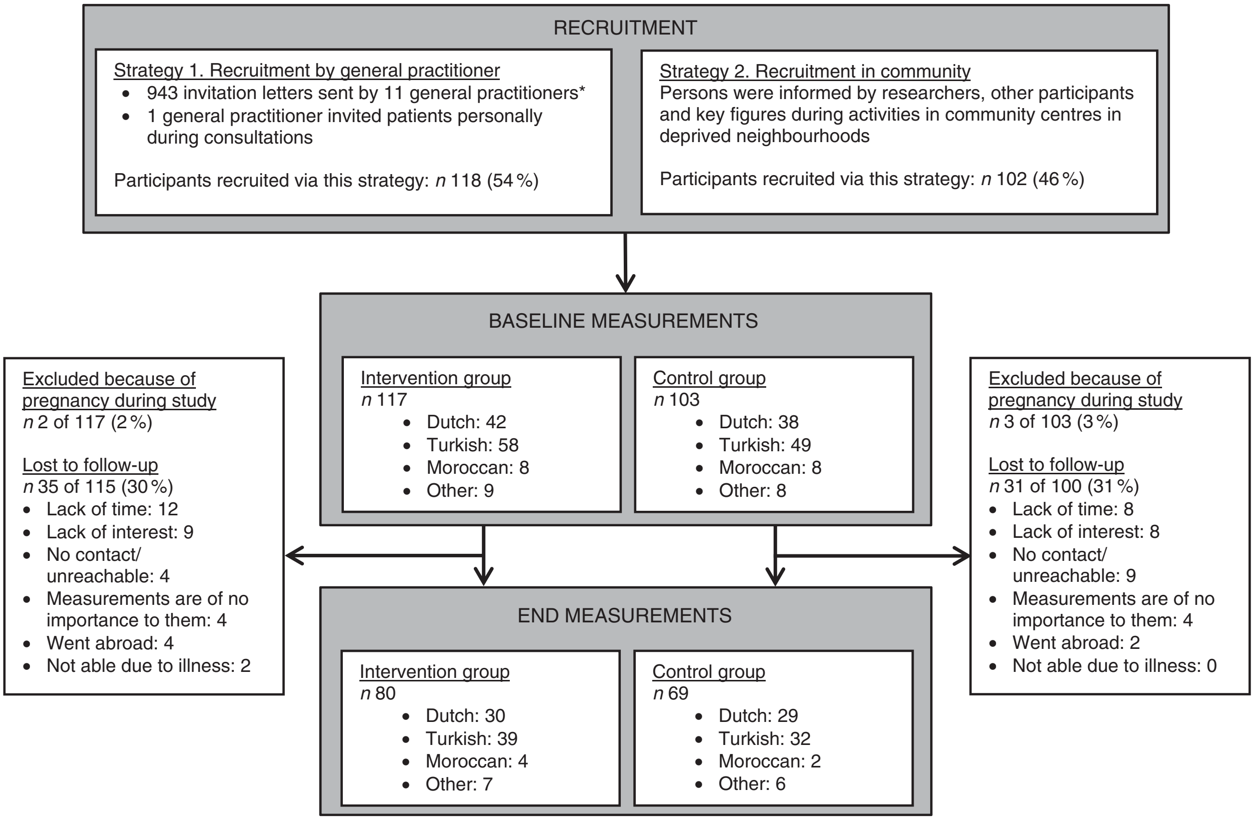

Fig 1 Flow diagram of the MetSLIM study. *Invitation letters were sent to individuals assumed to be Dutch (*n* 450), Turkish (*n* 423) or Moroccan (*n* 70)

(β = −1215 min/week, 95 % CI −2039, −390 for total amount of physical activity; β = − 1030 min/week, 95 % CI −1761, −299 for light-intensity physical activity).

Discussion

The results of this 1-year intervention study that targeted low-SES individuals of different ethnic origins are promising and show that a lifestyle intervention carried out in socio-economically deprived neighbourhoods can be successful. The lifestyle intervention significantly improved obesity-related measures such as waist circumference, WHtR, body weight, fat percentage and BMI. The lifestyle intervention did not affect prevalence of metabolic syndrome or components of metabolic syndrome, apart from waist circumference, within 12 months. However, total cholesterol and LDL cholesterol did improve significantly. Significant changes in lifestyle were observed for fibre intake (relative intake increased in the intervention group) and total minutes of self-reported physical activity (reduced in the intervention group) only. The intervention group also showed, although not significantly, a reduction in energy intake. With regard to quality of life, participants in the intervention showed improvements in 'general health' and 'health transition'. Overall, our data support an improvement in cardiometabolic risk and quality of life in the intervention group compared with the control group.

Our study, an adapted version of the SLIM study, was targeted at persons with low SES of different ethnic origins[25]. In the SLIM study, weight loss and reduction in waist circumference were significantly different after 12 months between the intervention and the control group (−2·7 kg, −3·5 cm in the intervention group and −0·2 kg, −1·4 cm in the control group)[10]. This is comparable with our findings. The achieved reduction of waist circumference in our intervention group is also comparable to the results of a primary-care-based intervention study based on the DPP by Ma *et al.*[43] among participants with predominantly high SES. Our findings of reduction in weight and total cholesterol are comparable with another effect study of the DPP intervention translated to a community setting (i.e. the YMCA)[44]. We did not reproduce the beneficial results with regard to blood pressure, HDL cholesterol, TAG and fasting glucose after 12 months reported in other studies based on the DPP[5,7,45], or the reduction in fasting insulin levels after 12 months in the SLIM study[10]. However, in those studies, participants were selected on the basis of having pre-diabetes, metabolic syndrome or impaired glucose tolerance, or on the basis of being at high risk of developing diabetes (risk score tool), whereas participants in our study were included on the basis of elevated WHtR only.

Table 2 Baseline characteristics of participants (*n* 149) in the MetSLIM study targeting individuals of low socio-economic status and different ethnic origins with elevated waist-to-height ratio, the Netherlands, January 2013–June 2015

	INT (*n* 80)*		CON (*n* 69)*		
	n or Mean†	% or SD†	*n* or Mean†	% or SD†	*P*‡
Recruitment strategy					0·29
Invited by general practitioner	36	45	37	54	
Invited in community centre	44	55	32	46	
Gender					0·29
Male	11	14	14	20	
Female	69	86	55	80	
Age (years)	47·9	7·9	47·0	10·6	0·57
Ethnicity					0·89
Dutch	30	38	29	42	
Turkish	39	49	32	46	
Moroccan	4	5	2	3	
Other	7	9	6	9	
Educational level					0·10
No education	12	15	4	6	
Lowest education (primary)	24	30	17	25	
Low education (lower secondary)	20	25	15	22	
Middle education	18	23	20	29	
High education	6	8	13	19	
Employment status					0·11
No paid job	45	57	38	55	
Part-time job (<32 h/week)	25	32	15	22	
Full-time job (≥32 h/week)	9	11	16	23	
Household situation					0·13
Alone	17	22	13	19	
Together with partner	16	21	11	16	
Together with partner and child(ren)	38	49	29	42	
Single parent living with child (ren)	7	9	16	23	
Smoking status					0·92
Current	15	19	15	22	
Former	21	27	18	26	
Never	43	54	36	52	
Alcohol consumption					
No consumption	41	65	35	56	0·28
Low to moderate consumption	20	32	22	35	
Excessive consumption	2	3	6	10	
Metabolic syndrome					0·56
No	52	70	50	75	
Yes	22	30	17	25	
Metabolic syndrome components					0·43
0	8	11	11	16	
1	16	22	20	30	
2	28	38	19	28	
3	14	19	7	10	
4	7	9	9	13	
5	1	1	1	1	
Family history of type 2 diabetes in first-degree relative					0·39
No	45	58	44	65	
Yes	33	42	24	35	
History of hyperglycaemia					0·55
No	71	90	63	93	
Yes	8	10	5	7	
History of hypercholesterolaemia					0·54
No	65	82	54	78	
Yes	14	18	15	22	
History of hypertension					0·37
No	66	88	62	93	
Yes	9	12	5	7	

INT, intervention group; CON, control group.
*Employment status: INT *n* 79, CON *n* 69; household situation: INT *n* 78, CON *n* 69; smoking status: INT *n* 79, CON *n* 69; alcohol consumption: INT *n* 63, CON *n* 63; metabolic syndrome: INT *n* 74, CON *n* 67; metabolic syndrome components: INT *n* 74, CON *n* 67; family history of type 2 diabetes in first-degree relative: INT *n* 78, CON *n* 68; history of hypercholesterolaemia: INT *n* 79, CON *n* 69; history of hypertension: INT *n* 75, CON *n* 67.
†Data are expressed as *n* and % for categorical variables; or mean and SD for continuous variables.
‡*P* value of χ^2 tests or independent-samples *t* tests.

Because medication users were excluded during recruitment, a relatively healthy population was enrolled in our study. This might explain why we found no significant changes in blood pressure, HDL cholesterol, TAG and fasting glucose. Only 28 % of the participants in the MetSLIM study had metabolic syndrome; this is comparable to data on the general Dutch population aged 30–70 years (34 % of men and 24 % of women)[46]. Furthermore, the cut-off value of 0·5 might have been too low to select participants with metabolic syndrome, especially for the younger adults. A recent study identified a WHtR cut-off value of 0·580 as optimal for discriminating individuals with metabolic syndrome among younger adults[47].

Despite the beneficial changes in obesity measures, the intervention group did not report significant improvements in energy intake and physical activity. One would expect improvements in obesity measures to result from positive lifestyle changes. As obesity measures are expected to be more objective than self-reported lifestyle data, one could debate whether the self-reported lifestyle data in the current study were completely reliable. Questionnaire data can be subject to socially desirable answers and depend on participants' literacy skills, which might be relatively low in our target group. In this case, it could be that the intervention group got a more realistic view of their PA level and reported less PA, whereas the control group gave socially desirable answers and reported to engage in more PA.

In general, intervention effects were more beneficial among participants of Dutch origin than among participants of Turkish origin. However, these two groups were not completely comparable in the present study as they differed in, among other things, age, education level and intervention location (see Supplemental Table 1). Therefore, the results cannot be attributed to ethnicity only. In any case, the results imply that the intervention was less effective in the Turkish group that was reached in the present study and, in order to achieve greater effects, further adaptations for this group should be considered.

In the present study, low SES was determined by neighbourhood. A disadvantage of selecting participants on the basis of the neighbourhood they lived in was that higher educated persons were also able to participate in the study. However, when we included only the participants with a low educational level in our analyses, this did not change our conclusion significantly. In fact, the intervention effects seemed slightly better when excluding the higher educated participants (data not shown).

The dropout rate in MetSLIM (31 %) was relatively high compared with SLIM (10 % after the first year), but comparable to dropout rates in similar studies among low-SES populations[48] or ethnic minorities[20,49]. It can be questioned whether dropout can be reduced by further adaptations to the intervention study protocol. Reasons for dropout that were quite often mentioned were 'no time'

Table 3 Changes in cardiometabolic risk factors from baseline to 12 months among participants (*n* 149) in the MetSLIM study targeting individuals of low socio-economic status and different ethnic origins with elevated waist-to-height ratio, the Netherlands, January 2013–June 2015*

	INT†		CON†		Differences between groups		
	Mean	SD	Mean	SD	β	95 % CI	P‡
Anthropometric measures	*n* 80		*n* 69				
Waist circumference (cm)							
Baseline	99·1	11·2	97·6	11·2			
Change after 12 months	−3·4	4·7	− 0·2	4·3	−3·3	−4·7, −1·8	<0·001
Weight (kg)							
Baseline	83·7	14·7	82·7	14·1			
Change after 12 months	−2·2	5·4	−0·1	3·6	−2·2	−3·7, −0·8	0·003
BMI (kg/m^2)							
Baseline	31·7	4·7	30·5	5·0			
Change after 12 months	−0·8	1·9	−0·1	1·3	−0·8	−1·3, −0·3	0·003
Waist-to-height ratio							
Baseline	0·610	0·061	0·593	0·070			
Change after 12 months	−0·021	0·028	−0·001	0·026	−0·020	−0·028, −0·011	<0·001
Body fat (%)							
Baseline	37·5	6·8	35·9	7·9			
Change after 12 months	−0·7	2·6	0·2	2·6	−0·9	−1·8, −0·1	0·033
Blood pressure	*n* 75		*n* 69				
Systolic blood pressure (mmHg)							
Baseline	117·3	20·0	116·6	15·0			
Change after 12 months	−0·3	10·4	−1·0	11·2	0·6	−2·9, 4·1	0·73
Diastolic blood pressure (mmHg)							
Baseline	77·1	10·7	74·7	9·5			0·46
Change after 12 months	−1·3	6·9	−0·3	7·8	−0·9	−3·4, 1·5	
Blood markers	*n* 72		*n* 61				
Fasting glucose (mmol/l)							
Baseline	5·38	0·91	5·30	1·34			
Change after 12 months	−0·22	0·57	−0·17	0·51	−0·06	−0·23, 0·12	0·53
Fasting insulin (pmol/l)							
Baseline	66·73	38·71	71·27	30·89			
Change after 12 months	−1·94	39·05	−0·84	44·73	−0·57	−15·28, 14·14	0·94
HbA1c (mmol/mol)							
Baseline	37·23	5·81	36·83	9·30			
Change after 12 months	1·09	3·43	0·28	2·63	0·84	−0·23, 1·91	0·12§
HOMA-IR							
Baseline	2·67	1·68	2·86	1·65			
Change after 12 months	−0·19	1·69	−0·13	1·63	−0·09	−0·68, 0·50	0·76
Total cholesterol (mmol/l)							
Baseline	5·56	0·95	5·28	0·87			
Change after 12 months	−0·26	0·61	0·03	0·71	−0·33	−0·56, −0·10	0·005
HDL cholesterol (mmol/l)							
Baseline	1·41	0·32	1·44	0·39			
Change after 12 months	0·04	0·19	0·00	0·21	0·05	−0·02, 0·12	0·14
LDL cholesterol (mmol/l)							
Baseline	3·48	0·87	3·20	0·82			
Change after 12 months	−0·28	0·58	0·04	0·64	−0·35	−0·56, −0·14	0·001
TAG (mmol/l)							
Baseline	1·45	0·77	1·40	0·67			
Change after 12 months	−0·06	0·50	−0·02	0·53	−0·05	−0·23, 0·13	0·57
Alanine aminotransferase (U/l)							
Baseline	21·75	8·65	24·62	13·59			
Change after 12 months	−1·07	7·4	1·43	12·94	−2·50	−6·19, 1·19	0·18
Aspartate aminotransferase (U/l)							
Baseline	23·01	4·96	22·95	6·03			
Change after 12 months	−1·83	4·65	−0·25	7·12	−1·43	−3·53, 0·66	0·18
γ-Glutamyl transferase (U/l)							
Baseline	24·51	17·96	25·75	23·16			
Change after 12 months	−2·59	11·99	1·07	16·66	−3·65	−8·70, 1·39	0·15
Creatinine (umol/l)							
Baseline	66·14	9·20	65·59	12·62			
Change after 12 months	0·72	5·32	2·48	6·56	−1·75	−3·78, 0·27	0·09
Uric acid (mmol/l)							
Baseline	0·29	0·07	0·27	0·07			
Change after 12 months	−0·014	0·035	0·000	0·047	−0·014	−0·028, 0·001	0·07
C-reactive protein (mg/l)							
Baseline	3·07	2·37	2·73	2·38			
Change after 12 months	0·09	2·00	0·17	2·32	−0·19	−0·99, 0·62	0·65

INT, intervention group; CON, control group; HbA1c, glycated Hb; HOMA-IR, homeostatic model assessment of insulin resistance.
*Date are expressed as mean and SD; or β and 95 % CI.
†Body fat: INT *n* 76, CON *n* 69; fasting insulin: INT *n* 71, CON *n* 61; HbA1c: INT *n* 70, CON *n* 60; HOMA-IR: INT *n* 71, CON *n* 61; TAG: INT *n* 72, CON *n* 60; alanine aminotransferase: INT *n* 71, CON *n* 61; aspartate aminotransferase: INT *n* 71, CON *n* 60; γ-glutamyl transferase: INT *n* 71, CON *n* 61; uric acid: INT *n* 71, CON *n* 61; C-reactive protein ≤ 10 mg/l: INT *n* 61, CON *n* 56.
‡*P* value for difference between treatment groups in ANCOVA test, adjusted for ethnicity and individuals' mean value of the measurements at baseline and 12 months for the respective variable.
§Excluding participants using relevant medication (*n* 2) from the analysis resulted in a *P* value of 0·044.

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Table 4 Changes in dietary intake (*n* 98) and physical activity (*n* 125) from baseline to 12 months among participants in the MetSLIM study targeting individuals of low socio-economic status and different ethnic origins with elevated waist-to-height ratio, the Netherlands, January 2013–June 2015*

	INT†		CON†		Differences between groups		
	Mean	SD	Mean	SD	β	95 % CI	*P*‡
Dietary intake	*n* 61		*n* 37				
Energy intake (kJ/d)							
Baseline	10 294	4744	9364	3674			
Change after 12 months	–1780	4652	–579	2594	–1359	–3082, 363	0·12
Energy intake (kcal/d)							
Baseline	2460	1134	2238	878			
Change after 12 months	–425	1112	–138	620	–325	–736, 87	0·12
Total protein (% of energy)							
Baseline	16·1	2·7	16·2	2·3			
Change after 12 months	0·8	3·0	0·3	2·2	0·7	–0·5, 1·8	0·25
Total fat (% of energy)							
Baseline	34·5	6·2	34·8	5·4			
Change after 12 months	–0·1	8·1	–0·3	3·9	–0·9	–3·8, 2·0	0·55
Saturated fat (% of energy)							
Baseline	12·6	3·0	12·5	2·9			
Change after 12 months	–0·3	3·7	–0·0	2·3	–0·8	–2·2, 0·5	0·22
Total carbohydrates (% of energy)							
Baseline§	43·3	7·1	40·3	6·7			
Change after 12 months	–0·8	8·2	0·1	4·5	0·3	–2·7, 3·3	0·85
Fibre (g/4184 kJ (1000 kcal))							
Baseline	10·9	3·1	10·8	2·8			
Change after 12 months	0·8	3·3	–0·2	2·1	1·5	0·3, 2·7	0·016
Fruit intake (g/d)							
Baseline	205	258	201	249			
Change after 12 months	–5	261	–32	201	54	–36, 144	0·23
Vegetable intake (g/d)							
Baseline	148	123	159	133			
Change after 12 months	–3	122	–21	98	20	–30, 70	0·43
Dutch Healthy Diet index (0–80 scale)							
Baseline	57·0	9·9	57·6	9·8			
Change after 12 months	0·3	9·3	–0·1	6·8	1·5	–2·2, 5·2	0·42
Physical activity (PA)	*n* 62		*n* 63				
Total PA (min/week)							
Baseline	2372	1784	2274	1301			
Change after 12 months	–362	1447	211	1611	–573	–1126, –21	0·042
Light PA (min/week)							
Baseline	1608	1106	1677	1067			
Change after 12 months	–243	1071	248	1344	–434	–873, 5	0·053
Moderate PA (min/week)							
Baseline	643	1098	457	525			
Change after 12 months	–79	894	–9	657	–54	–333, 225	0·70
Vigorous PA (min/week)							
Baseline	120	239	141	423			
Change after 12 months	–40	193	–28	327	–27	–118, 64	0·56

INT, intervention group; CON, control group.
*Data are expressed as mean and SD; or β and 95 % CI.
†Dutch Healthy Diet index: INT *n* 60, CON *n* 36.
‡*P* value for difference between treatment groups in ANCOVA test, adjusted for ethnicity and individuals' mean value of the measurements at baseline and 12 months for the respective variable.
§Significantly different between INT and CON at baseline.

and 'no interest'. Participants elaborated on this by mentioning that they had conflicting issues to worry about in life, for example sick relatives. Other researchers have reported that 'life stressors' can interfere with participation in a lifestyle intervention[48]. Such dropout is hard to prevent in a lifestyle intervention focusing exclusively on diet and physical activity. Furthermore, some of the reasons for dropout (e.g. moving to another area) or exclusion from the analyses (e.g. pregnancy) cannot be prevented by adaptation measures.

A limitation of our study was that some participants did not fill in the questionnaires or did not go for their blood test at the medical laboratory. For future studies, it could help to limit the number of measurements (several participants expressed dissatisfaction about the large burden of the measurements) and focus on completing the most important measurements. It would also be advisable to combine measurements; that is, have all measurements at the same time and location. However, that may be practically challenging in community settings.

Table 5 Changes in quality of life from baseline to 12 months among participants (n 129) in the MetSLIM study targeting individuals of low socio-economic status and different ethnic origins with elevated waist-to-height ratio, the Netherlands, January 2013–June 2015*

	INT (n 64)†		CON (n 65)†		Differences between groups		
	Mean	SD	Mean	SD	β	95 % CI	P‡
Health transition							
Baseline	43·7	20·6	50·4	23·2			
Change after 12 months	22·2	32·7	–0·4	28·5	21·6	10·7, 32·5	< 0·001
General health							
Baseline	58·4	21·4	60·6	17·9			
Change after 12 months	8·2	16·8	–1·5	12·3	9·2	3·9, 14·5	< 0·001
Physical functioning							
Baseline	74·8	23·2	78·5	20·2			
Change after 12 months	5·0	20·8	2·9	17·0	1·5	–5·1, 8·1	0·65
Role physical							
Baseline	70·0	40·6	71·8	38·8			
Change after 12 months	–7·5	36·0	–3·2	46·3	–4·7	–19·9, 10·5	0·54
Role emotional							
Baseline	72·5	41·4	78·5	39·2			
Change after 12 months	–2·9	43·3	7·0	41·4	–9·7	–25·5, 6·1	0·22
Social functioning							
Baseline	78·5	25·3	76·9	27·0			
Change after 12 months	–3·5	32·8	4·2	23·6	–7·5	–17·5, 2·5	0·14
Bodily pain							
Baseline	65·6	28·9	69·7	26·0			
Change after 12 months	–0·2	27·3	–3·5	23·5	3·9	–5·0, 12·9	0·39
Vitality							
Baseline	53·0	20·1	56·4	22·8			
Change after 12 months	4·5	22·4	–1·0	17·3	5·0	–2·0, 12·1	0·16
Mental health							
Baseline	66·7	18·4	66·6	17·6			
Change after 12 months	2·6	17·1	0·4	17·5	2·1	–4·0, 8·1	0·50

INT, intervention group; CON, control group.
*Data are expressed as mean and SD; or β and 95 % CI.
†Health transition: INT n 63, CON n 65; general health: INT n 62, CON n 63; physical functioning: INT n 61, CON n 65; role physical: INT n 60, CON n 62; role emotional: INT n 57, CON n 62; bodily pain: INT n 63, CON n 65; vitality: INT n 62, CON n 65; mental health: INT n 62, CON n 65.
‡P value for difference between treatment groups in ANCOVA test, adjusted for ethnicity and individuals' mean value of the measurements at baseline and 12 months for the respective variable.

Another limitation is the low number (19 %) of male participants in the MetSLIM study. Other lifestyle intervention studies also report low participation rates among men[4,50]. The MetSLIM study focused on individuals of Dutch, Turkish and Moroccan origin. However, we did not succeed in recruiting many participants of Moroccan origin. This could possibly have been because we found especially good contact persons within the Dutch and Turkish communities, for example ethnicity-matched general practitioners and a Turkish research assistant with contacts at the intervention locations. Other researchers have concluded that ethnicity-matched recruiters result in better reach to the target group[51]. We will investigate this issue further in the process evaluation of the MetSLIM study (forthcoming).

Finally, the quasi-experimental design could be considered a limitation. However, although randomised controlled trials are highly valued, it is debateable if randomised controlled trials are the appropriate research method to evaluate complex interventions[52]. In our case, it was considered that randomisation would not be feasible, and even undesirable. As most persons in our target group are probably unfamiliar with research and randomisation, it could have easily provoked dissatisfaction and non-participation if participants were randomly allocated to intervention and control groups, especially within one community. A selective response could therefore be expected with a randomised controlled trial, which would have threatened the recruitment of the target group and the external validity of the study.

Conclusions

In conclusion, the current study showed that the adapted SLIM lifestyle intervention targeting low-SES individuals of different ethnic origins is effective in improving waist circumference, total and LDL cholesterol, and quality of life after 12 months. Future research is required to investigate whether further adaptations to the lifestyle intervention may be necessary to enhance its effectiveness among different ethnic minorities and to investigate how men and persons of Moroccan origin can be more successfully reached for this lifestyle intervention.

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Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/S1368980017001458

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