Baseline characteristics

Table 1. Demographic characteristics of the participants in the physical activity and nutrition group vs the control group

	n	PAN (M ± SD)	n	CG (M ± SD)
Age (years)	22	14.5 ± 0.7	19	13.9 ± 0.6
Weight (kg)	22	79.9 ± 14.9	19	73.6 ± 16.9
Height (cm)	22	161.2 ± 9.5	19	163.4 ± 10.4
Ethnicity (%)	22	100	19	100
Black	17	77.3	13	68.4
Indian	2	9.1	0	0
Caucasian	3	13.6	6	31.6
Gender (%)	22	100	19	100
Male	7	31.8	11	57.9
Female	15	68.2	8	42.1

Table 2. Prevalence of abnormal blood pressure and biochemical measurements (N=41)

Variable	Pre (%)	Post (%)
Systolic blood pressure		
Normal (< 90th percentile)	20 (48)	27 (66)
Elevated (≥ 90th – < 95th percentile)	7 (17)	6 (15)
Hypertension stage 1 (≥ 95th percentile)	8 (20)	7 (17)
Hypertension stage 2 (≥ 95th percentile + 12 mmHg)	6 (15)	1 (2)
Diastolic blood pressure		
Normal (< 90th percentile)	32 (78)	35 (86)
Elevated (≥ 90th – <95th percentile)	1 (2)	0 (0)
Hypertension stage 1 (≥ 95th percentile)	8 (20)	5 (12)
Hypertension stage 2 (≥ 95th percentile + 12 mmHg)	0 (0)	1 (2)
Blood pressure		
Normal (< 90th percentile)	17 (41)	24 (59)
Elevated (≥ 90th – <95th percentile)	8 (20)	6 (15)
Hypertension stage 1 (≥ 95th percentile)	10 (24)	10 (24)
Hypertension stage 2 (≥ 95th percentile + 12 mmHg)	6 (15)	1 (2)
ALT (Males: > 31, Female: > 25 U/L)	2 (5)	2 (5)
HDL-C (< 0.9 mmol/L)	2 (5)	1 (2)
LDL-C (> 3.4 mmol/L)	3 (7)	1 (2)
Insulin (≥ 20 mU/ml)	7 (17)	5 (12)
HOMA-IR (≥ 3.4)	6 (15)	5 (12)
TG (≥ 1.4 mmol/L)	2 (5)	0 (0)

ALT - Alanine aminotransferase; HDL-C - High density lipoprotein cholesterol; LDL-C - Low density lipoprotein cholesterol; HOMA-IR - homeostatic model assessment of insulin resistance; TG = Triglycerides

Adverse events

None to report

Outcome measures

For Phase I, all grade 8 and 9 learners' height and weight were measured at school in groups of between 100 and 150 learners per day over three days. Phase II of the study commenced one week after the identification of eligible learners. On arrival at school in the morning after a 9-hour fast blood pressure (BP) was measured after which the 20 ml blood sample was collected from the antecubital vein. The learners then received light refreshments, after which the demographic information was completed. Phase II data were collected at baseline and 10 weeks post-intervention.

Anthropometrical measures

Height (SECA model 217) and weight (AND UC-321, A&D Medical) was measured according to the standards of the International Society for the Advancement of Kinanthropometry (ISAK) (Marfell-Jones et al., 2012). All measurements were repeated twice, with a third measurement if the first two measurements in weight differed by more than 100 g or the height by 0.1 cm. The nearest two measurements were averaged and used in the data analyses. Weight was measured in school uniform without blazers and shoes. A weight of 400 g for girls and 800 g for boys was subtracted from the measurement to compensate for the school uniform. The measurements were entered into the World Health Organisation software WHO AnthroPlus to calculate the BMI as weight/height2 (kg/m2) and to plot the BMI on the growth charts (WHO, 2011). The Centre for Disease control BMI-based definitions of overweight (≥85th percentile) and obesity (≥95th percentile) were used to identify learners eligible for inclusion in Phase II (WHO, 2020).

The BMI Z-scores were used as an outcome measurement of the intervention as changes could be more accurately monitored from pre to post-intervention. Overweight was defined as >+1SD and obesity as >+2SD (WHO, 2020).

Biochemical measures

Biochemical analyses were performed on the plasma prepared from the collected fasting blood samples. Samples were collected in VACUCARE blood collection tubes (EREZ labmed, Midrand, South Africa). The tubes were stored at between 2°C to 8°C and the analysis completed within 8 hours of collection. Fasting serum insulin concentrations were assessed using a chemiluminescent microparticle immunoassay (Abbott Architect System, Irving, TX, USA). Plasma glucose and glycated hemoglobin (HbA1c) were measured using Vitros DT60 II Chemistry Analyser (Ortho-Clinical Diagnostics, Rochester, NY, USA) with VITROS reagents and control. Elevated HbA1C was defined ≥ 6.2% (Yoon et al., 2018). Plasma triglycerides (TG), high density lipoprotein cholesterol (HDL-C), and low density lipoprotein cholesterol (LDL-C) concentrations and alanine aminotransferase (ALT) were determined with an immunoradiometric assay (Active Human Leptin IRMA, DSL-23100, Diagnostic System Laboratories Inc., Webster, TX, USA).

The 2018 AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS/APhA/ASPC/NLA/PCNA Guideline on the Management of Blood Cholesterol was used to define abnormal cholesterol levels (HDL-C: <0.9 mmol/L, LDL-C: ≥3.4 mmol/L and TG as ≥1.4 mmol/L) (Grundy et al., 2019). LabCorp's ALT reference intervals as > 25 U/L for females aged 12-17 years and > 31 U/L for males aged 12-17 years were applied (LabCorp, 2013). Fasting insulin levels ≥ 20 mU/ml were considered hyperinsulinemic levels (Kostovski et al., 2018). Insulin resistance was computed using the homeostatic model assessment of insulin resistance (HOMA-IR) and assessed using the following formula: HOMA-IR = (fasting insulin [μIU/mL]×fasting glucose [mmol/L])/22.5 (Matthews et al., 1985). Insulin resistance was defined as HOMA-IR ≥3.4 (Van der Aa et al., 2014).

Blood pressure

Blood pressure was measured to the nearest two mmHg using an automated Omron sphygmomanometer (Omron Healthcare Europe B.V) and an appropriate size cuff for each participant as per the recommendations of the American Academy of Pediatrics (Flynn et al., 2017). The average of two readings, taken 2 minutes apart, was used in data analyses. The Clinical practice guidelines for screening and management of high blood pressure in children and

adolescents of the American Academy of Paediatrics (AAP) was used to classify systolic and diastolic blood pressure: <90th percentile as a normal systolic/diastolic blood pressure, >90th and <95th as elevated systolic/diastolic blood pressure and ≥95th as Stage 1 systolic/diastolic hypertension, and ≥ 95th percentile + 12 mm Hg as Stage 2 systolic/diastolic hypertension (Flynn et al., 2017). The American Academy of Paediatrics calculator, which is based on the AAP's 2017 Clinical Practice Guidelines, was used to classify the blood pressure into normal, elevated, Stage 1 and Stage 2 hypertension (Flynn et al., 2017).

Participant flow

Figure 1 shows the flow diagram with all reasons for learners' exclusion and abandonment of the intervention. It is of particular interest that two girls were excluded as they were identified on screening with previously undiagnosed diabetes mellitus. Learners in the control group were asked to maintain their current activities of daily living (ADL).

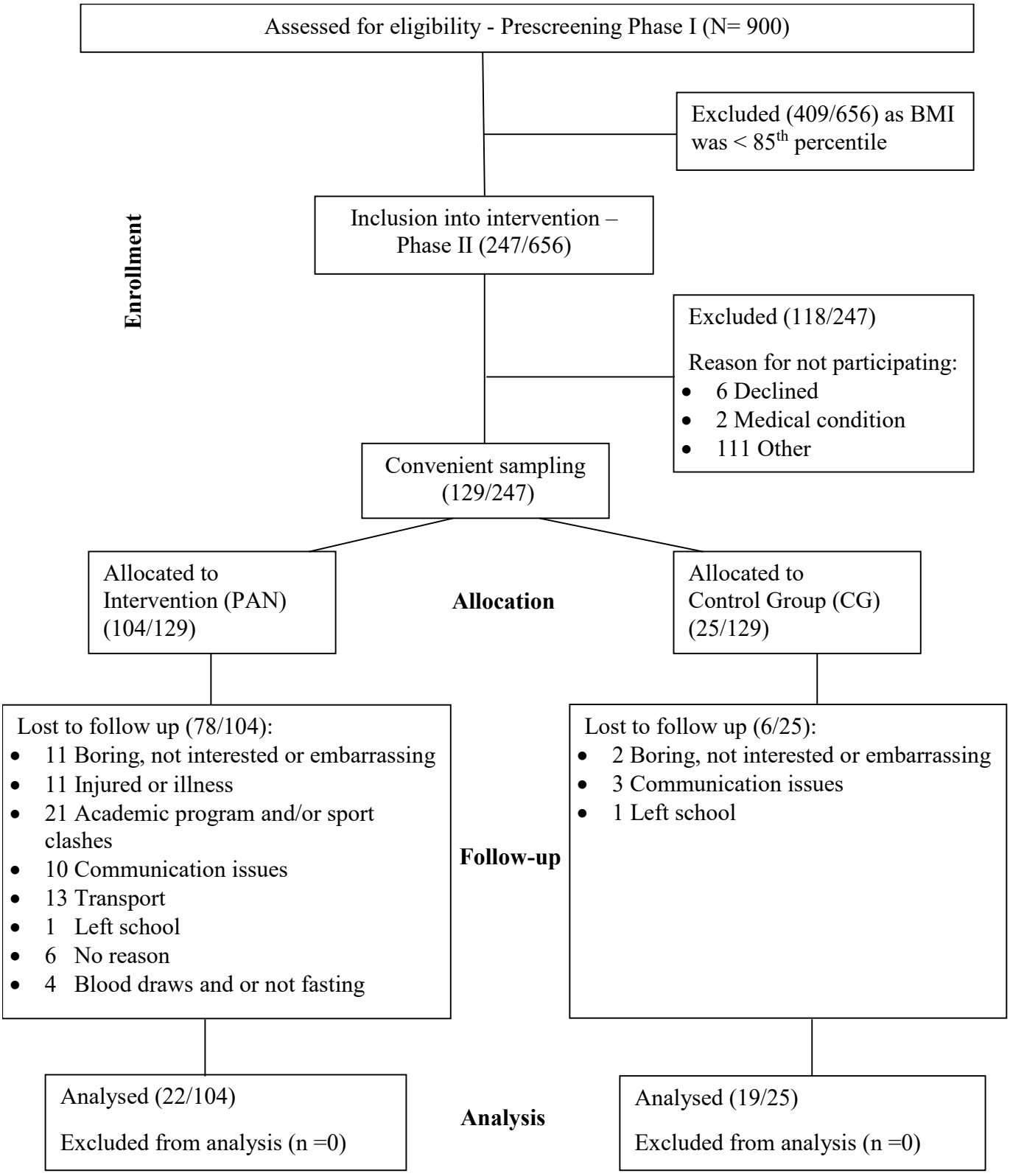

Figure 1. Participant flow diagram of physical activity and nutrition intervention compared to a control group in overweight and obese children