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Sykes-Muskett, BJ, Prestwich, A orcid.org/0000-0002-7489-6415, Lawton, RJ orcid.org/0000-0002-5832-402X et al. (1 more author) (2017) The effect of pair-based monetary contingency contracts for weight loss: Results from a randomized controlled pilot study. Obesity, 25 (3). pp. 506-509. ISSN 1930-7381

https://doi.org/10.1002/oby.21758

The effect of pair-based monetary contingency contracts for weight loss: Results from a randomised controlled pilot study.

Online Supplementary File 1: Detailed Methodology

Design

This study was a randomised controlled trial which adopted a mixed design, with changes in weight and body composition over time reflecting repeated measures variables. Participants were randomised according to a computer generated randomisation sequence, in pairs, base on the order in which they attended the first testing session (i.e., participants 1and 2 were paired, participants 3 and 4 were paired etc.). Participants were randomised in pairs for practical reasons, in order to ensure that pairs attended the first testing session around the same time and participants in the partner-based conditions could be sent their weight loss partner's contact details within 7 days. Pairs of participants were randomly allocated to one of four conditions: Partner with Pair-Based Refund (P-PBR); Partner with Individual Refund (P-IR), Individual with individual refund (I-IR); Comparison condition. Although participants in all conditions were randomised in pairs, only the pairs in the P-PBR and P-IR conditions were put in contact with each other to form 'weight loss partners'.

Ethical Approval and Participant Eligibility

The study was approved by the University of Leeds, School of Psychology Ethics Committee. Participants signed a consent form that included a screening questionnaire to ensure that it was safe for participants to lose weight. Individuals were eligible to participate in the study if they identified themselves as motivated to lose weight, and had a BMI above 25. Individuals were not eligible to participate if: they had lost weight at an unsafe rate during the last year; had experienced unexplained weight loss during the last year; were taking (or had taken during the last month) any medication that could influence the accumulation or expenditure of energy; had any cardiac problems; had uncontrolled hypertension; had a genetic syndrome associated with obesity; had untreated hyperthyroidism; were on a specific food avoidance diet (e.g., Atkins diet); had a significant health problem (e.g., diabetes); had a history of anaphylaxis to food; had undergone bariatric surgery; had any planned future surgery of any kind; had an eating disorder. Female participants were also not eligible if they were pregnant or breastfeeding.

Recruitment

To recruit participants, posters were placed around the university campus and in a local gymnasium, an advertisement was placed on the university alumni website, and the study was included in the weekly news bulletin email to all staff members in the university's faculty of medicine and health. The local council also sent an email to a subsection of their employees and placed and advertisement on the office noticeboard. An advertisement was also placed in a free local magazine in the area. After emailing or calling the researcher, potential participants were sent the participant information sheet via email and invited to arrange a time for their baseline appointment. All appointments were conducted either in a laboratory at the university (for those recruited from the university), or in the participants home (for those recruited from outside the university). All participants were recruited and tested between September 2013 and August 2014.

Procedure

Baseline (Time 1). At the baseline appointment, participants were given the opportunity to read the participant information sheet again, and were asked if they had any questions about the study. They were then asked to complete the consent form, which was then checked by the researcher, and any potential issues discussed with the participant to ensure eligibility. Height and body composition measures were then taken. Following this, participants were asked to complete the first baseline questionnaire, which included some general background questions (gender; age), a measure of weight loss intention and additional psychosocial measures not presented in this paper. Participants in the P-PBR and P-IR conditions were then provided with an additional information sheet, which explained further procedures (i.e., the weight loss partner system). All participants were then provided with the weight loss goal sheet for which the researcher verbally outlined the participant's current weight, their weight loss goal to be achieved over the following 4 weeks, and their target weight based on this weight loss goal. The researcher explained that the weight loss goal was based on real weight losses achieved in previous research, and safe weight loss guidelines. The researcher then went through the weight loss materials (see Weight Loss Materials) with the participant, and explained each section to them before asking if they had any questions about the weight loss materials, or any other aspect of the study.

When the participant was satisfied with all aspects, they paid the monetary deposit (see Monetary Deposit). After paying the monetary deposit, participants were asked to fill in the second baseline questionnaire, which included the same measures as the first baseline questionnaire. Participants in the P-PBR and P-IR conditions were then asked to provide the

contact information that they would be happy to share with their allocated weight loss partner. At the end of the baseline session, participants in the I-IR and comparison conditions were encouraged to book their time 2 appointment. Participants in the P-PBR and P-IR conditions were informed that as their time 2 meeting (scheduled for week 4) would be with their weight loss partner present also, the researcher would email them to arrange a time convenient for them and their partner.

Time 2 (4 weeks from baseline). Four weeks after the baseline session, all participants returned for a follow up session. For participants in all conditions, body composition measures were taken at the beginning of the session. All participants were told the percentage of the weight loss goal they had achieved and those in the P-PBR, P-IR and I-IR conditions were refunded accordingly (see section Manipulations0). All participants were then informed that the weight loss goal for the following 4 weeks would be the same as the previous weight loss goal. Participants in the P-PBR, P-IR and I-IR conditions were then given the opportunity to make another monetary deposit, which would be refunded at time 3 (week 8) following the same procedures (depending on their condition). At the end of this testing session, participants in all conditions were asked to complete a questionnaire involving the same measures as the second baseline questionnaire (including weight loss intention). Participants in the I-IR and comparison conditions were encouraged to book their time 3 appointment. Participants in the P-PBR and P-IR conditions were informed that as their time 3 meeting would again be with their weight loss partner present also, the researcher would email them to arrange a time convenient for them and their partner.

Time 3 (8 weeks from baseline). Four weeks after the time 2 follow up session, all participants returned for the final follow up session at time 3. Body composition measures were firstly taken, and participants in the P-PBR, P-IR and I-IR conditions were refunded following the same procedures as at time 2. Participants in all conditions were then informed that if they would like to carry on with their weight loss after this final session, their weight loss goal for the following 4 weeks would be the same as the weight loss goal for the preceding 4 weeks. All participants then completed the final questionnaire, which included the same measures from the previous questionnaires. Following this, participants were thanked for their time and told that they would receive a debriefing sheet to explain the aims of the study by email after all participants had completed the study.

Monetary Deposit

Participants were informed that they were free to choose their own monetary deposit amount, but were also provided with a suggested amount. The amount suggested to participants for the present study was calculated based on the amounts that individuals indicated they would be willing to pay into monetary contingency contracts for weight loss in a previous questionnaire based study (Sykes-Muskett et al., Unpublished Data). The deposit amount suggested to participants was £50. When choosing their deposit amount, participants were encouraged that the amount should be large enough to be motivating, but not so large that they would suffer financial deprivation were they to lose it. As previous research suggests that weight loss is greater when the deposit is paid as smaller instalments rather than as one lump sum at the start of the study (Sykes-Muskett et al., 2015), the payment of the deposit was split over two payments, one at baseline and one at the 4 week follow up (although the payment of the second instalment was not compulsory, participants could continue their participation in the study past the 4 week follow up even if they only paid the first instalment of the deposit). All forfeited money was donated to a heart disease charity, but participants were not informed of this during the intervention.

Manipulations (Interventions)

Partner with Pair-Based Refund (P-PBR). At baseline, after completing the first baseline questionnaire, participants in the P-PBR condition were provided with an additional information sheet, which explained that they would be allocated a weight loss partner. It was explained that their partner would be somebody else taking part in the study, and that at time 2 and time 3, the refund of their deposit would be contingent on the average weight loss goal achievement of themselves and their partner. This was done by calculating the percentage of the weight loss goal that each partner had achieved and then taking the average of these two percentages. Each partner was then refunded the corresponding percentage of the deposit amount they had paid at baseline. Within seven days from the baseline testing session, participants in the P-PBR and P-IR conditions were emailed with the contact details of their weight loss partner. This email encouraged participants to have as much contact with their partner as possible throughout the programme via email, phone, text message and/or in person. Additionally, to aid communication, the email contained a suggested topic of conversation for each week of the programme (e.g., portion sizes, finding time for exercise, eating healthily in social situations). The email also suggested that participants may find the support of their partner particularly helpful during times when they struggled with their weight loss. One week after the contact details were sent, participants were sent an email to

check that they had been able to contact their partner, and reminding them to contact the researcher if they were experiencing any problems with this.

At time 2 and time 3, the sessions were conducted together with the weight loss partner. After both partners were weighed at these sessions, both participants were told the percentage of the weight loss goal they had achieved. They were then told the percentage of the goal that the two partners had achieved on average, and each of the two participants was refunded the corresponding percentage of their baseline deposit.

Partner with Individual Refund (P-IR). All procedures in this condition were the same as in the P-PBR condition, except that the refunds at time 2 and time 3 were contingent on the percentage of the weight loss goal that the participant themselves had achieved only, rather than the average achievement between the partners. Therefore, although the follow up sessions at time 2 and time 3 were still conducted with the two partners together, the two participants were each simply told the percentage of their goal they had personally achieved, and were then refunded individually the corresponding percentage of their deposit.

Individual Weight Loss with Individual Refund (I-IR). In this condition, the monetary depositing and refunding procedures were the same as in the P-IR condition. Participants in this condition were not allocated a weight loss partner and all follow up sessions were conducted with the participants individually.

Comparison Condition. Immediately after paying the deposit at baseline, participants in this condition were informed that they were asked to pay a deposit only to ensure they were motivated to lose weight, and so they would be refunded their deposit immediately. At the follow up sessions at time 2 and time 3, after being weighed, participants were simply told the percentage of the weight loss goal that they had achieved. Participants in this condition received the same additional weight loss materials as participants in the experimental conditions.

Weight Loss Goal

In order to calculate the weight loss goal, data from a review by Perri and Fuller (1995) was used to calculate the mean average weight loss per week in 56 behavioural weight loss interventions (weighted by the number of studies), which equalled -0.57% (SD = 0.09) of baseline body weight. This was then multiplied by 8 as the duration of the current study was 8 weeks. Therefore, successful weight loss in the present study was calculated as a loss of 4.56% of initial body weight at time 3 (8 weeks from baseline). This overall goal was split

into two, so that participants were asked to lose 2.28% of their baseline weight between time 1 and time 2, and 2.28% between time 2 and time 3. Therefore, this weight loss goal is realistic as it is based on actual weight losses achieved in previous behavioural interventions, and is adherent to safe weight loss guidelines (National Institute for Health and Clinical Excellence, 2014).

Weight Loss Materials

Behaviour change techniques. Participants in all conditions (including the comparison condition) were also provided with additional weight loss materials, including clear dietary advice. The weight loss materials focused on a few key components (i.e., fruit and vegetable intake, the consumption of foods to increase 'fullness', the reduced consumption of foods high in fat and/or sugar) and avoided any 'fad' dietary practices (e.g., total avoidance of specific food groups). The weight loss materials were based on the findings of a review by Dombrowski, Sniehotta, Avenell, et al. (2012), which investigated the most effective components of behavioural intervention for obese adults with co-morbidities. The techniques to improve dietary behaviours identified as most effective were: provision of instructions; relapse prevention; self-monitoring and the combination of techniques associated with Control Theory (e.g., goal setting) (Carver & Scheier, 1982). Participants were provided with a weight loss manual incorporating these techniques.

Measures

Anthropometric measures. Height was measured to the nearest centimetre, without shoes, using a stadiometer. Body composition (weight, percentage body fat, fat mass, muscle mass, visceral fat rating, degree of obesity and body mass index) were measured via bioelectrical impedance analysis (Tanita model BC-420MA). Visceral fat rating ranges from 1 to 60, with a rating between 1 and 12 considered in the healthy range. A reading above 12 indicates an unhealthy level of visceral fat. The ratings equate to the area of visceral fat in the individual. For example, a reading of 6 would equate to $60cm^2$ of visceral fat. Degree of obesity is calculated as the percentage of excess weight above 'ideal weight' (ideal weight is when BMI is 22). Bioelectrical impedance analysis has been validated by comparison to other body composition measures (Bolanowski & Nilsson, 2001) and shown to be a useful clinical method for assessing change in body composition (Kushner et al., 1990). Participants were asked to remove any socks or tights and the foot pad of the analyser was wiped using alcohol wipes in view of the participant, for hygiene reasons and also to improve conductivity

between the skin and the electrodes. Participants were then asked to step onto the electrodes and stay still and relaxed with their hands by their sides for a few seconds whilst the analyser calculated the body composition measurements.

Weight Loss Intention. Weight loss intention was assessed by a measure adapted from Schifter and Ajzen (1985) which averaged responses to four items on 7-point scales. The four items are: "I intend to reduce my weight by my weight loss goal over the next four weeks" and "I will try to reduce my weight by my weight loss goal over the next four weeks" (both 'unlikely' (1) to 'likely' (7)), "I have decided to reduce my weight by my weight loss goal during the next four weeks" ('false' (1) to 'true' (7)) and "I am determined to reduce my weight by my weight loss goal during the next four weeks" ('not at all' (1) to 'very' (7)). The mean of these four items was then calculated and a higher score indicates higher intention. This measure has previously been found to be valid and internally reliable (Schifter & Ajzen, 1985) and was found to be internally reliable in the present study (Cronbach's $\alpha > .82$ at each time point).

Online Supplementary File 2: Additional Results

Details of Multiple Imputation

Multiple imputation was conducted for each anthropometric measure separately (weight (kg); BMI; fat mass (kg); percent fat; muscle mass (kg); visceral fat rating; degree of obesity). For each multiple imputation, condition (P-PBR/P-IR/I-IR/comparison) and the specific anthropometric measure at baseline, 4 weeks and 8 weeks were imputed and used as predictors. Results reported in the present paper are pooled results unless stated otherwise.

Participant Retention

Rates of study completion for each condition are shown in Table S1. With regards to the recommended sample size for a pilot study of 12 participants per condition (Julious, 2005), at least 12 participants completed the study in all conditions except the comparison condition, which had only 11 completing participants.

Table S1. Rates of study completion for each condition

	Total n	Completers at time 2	Completers at time 3
P-PBR	16	12 (75%)	12 (75%)
P-IR	20	15 (75%)	14 (70%)
I-IR	22	15 (68.2%)	12 (54.5%)
Comparison	19	14 (73.7%)	11 (57.9%)
Total	77	56 (72.7%)	49 (63.6%)

Note. P-PBR = partner with pair-based refund, P-IR = partner with individual refund, I-IR = individual with individual refund

Partner Contact

Of the 4 participants in the P-PBR condition who completed a follow up questionnaire regarding their thoughts about the intervention, only 2 responded to questions regarding the weight loss partner system. With regards to the P-IR condition, 12 participants completed the follow up questionnaire. The results were similar, although participants in the P-PBR condition indicated that they met their partner in person more times and found the partner system more useful than those in the P-IR condition. See Table S2 for descriptive statistics for each question per condition.

Table S2. Means and standard deviations for responses to questions regarding weight loss partner system.

Item	P-PBR (n = 2)	P-IR (n = 12)
How many times on average per week did you contact your weight loss partner?	1.50 (0.71)	1.32 (0.96)
How many times on average per week did your partner contact you?	1.50 (0.71)	1.21 (0.99)
How many times did you meet with your partner in person?	4.00 (0.00)	1.08 (1.56)
How useful did you find the weight loss partner system?[a]	4.50 (0.71)	2.58 (1.51)
To what extent do you feel that you built up a positive, supportive relationship with your partner?[b]	3.67 (1.15)	2.50 (1.35)
How much did the fact that your refund depended on the weight loss of you and your partner affect the amount you paid at the first study meeting?[b]	4.00 (0.00)	N/A

Note. P-PBR = partner with pair-based refund, P-IR = partner with individual refund. [a] Scale from 1 (not at all useful) to 5 (very useful), [b] Scale from 1 (not at all) to 5 (very much so)

Table S3. Means and standard deviations for visceral fat rating and degree of obesity at baseline

	Mean (SD)				
	P-PBR	P-IR	I-IR	Comparison	Total
n	16	20	21	19	76
Visceral Fat Rating	10.13 (8.62)	7.90 (2.65)	8.62 (3.35)	11.11 (11.80)	9.93 (8.74)
Degree of Obesity (%)	42.14 (36.04)	40.42 (19.64)	40.19 (20.56)	42.45 (22.57)	41.23 (24.36)

Note. P-PBR = partner with pair-based refund, P-IR = partner with individual refund, I-IR = individual with individual refund

Table S4. Means and standard errors for change in visceral fat rating and degree of obesity

		P-PBR	P-IR	I-IR	Comparison	Total
n		16	20	21	19	76
Visceral Fat Rating	4 weeks	-0.38 (0.20)	-0.04 (0.17)	-0.06 (0.17)	-0.19 (0.19)	-0.15 (0.10)
	8 weeks	-0.96 (0.17)	-0.20 (0.18)	0.02 (0.14)	-0.21 (0.22)	-0.31 (0.10)
Degree of Obesity (%)	4 weeks	-2.41 (0.79)	-1.60 (0.56)	-1.39 (0.61)	-1.93 (0.89)	-1.79 (0.44)
	8 weeks	-3.84 (0.89)	-2.92 (0.78)	-0.04 (0.79)	-2.23 (1.16)	-2.10 (0.56)

Note. Pooled statistics following multiple imputation. P-PBR = partner with pair-based refund, P-IR = partner with individual refund, I-IR = individual with individual refund.

Table S5. Regression statistics for visceral fat rating and degree of obesity for all experimental conditions vs. Comparison condition

		P-PBR vs. Comparison	P-IR vs. Comparison	I-IR vs. Comparison
		B (SE)	B (SE)	B (SE)
Visceral Fat Rating	4 weeks	-0.160 (0.20)	0.248 (0.24)	0.201 (0.25)
	8 weeks	-0.747** (0.26)	0.034 (0.31)	0.206 (0.236)
Degree of obesity	4 weeks	-0.497 (1.02)	0.247 (0.81)	0.473 (1.03)
	8 weeks	-1.606 (1.29)	-0.725 (1.21)	2.286 (1.39)

Note. Pooled statistics following multiple imputation. For all regressions, the conditions were coded as 1 vs. 0. P-PBR = partner with pair-based refund, P-IR = partner with individual refund, I-IR = individual with individual refund ** $p < .01$

Table S6. Cohens d and 95% confidence intervals for primary outcome measures for each experimental condition vs. comparison condition

		P-PBR vs. Comparison		P-IR vs. Comparison		I-IR vs. Comparison	
		Cohens d	95% CI	Cohens d	95% CI	Cohens d	95% CI
Weight (kg)	4 weeks	-0.127	-1.521, 1.047	0.298	-0.435, 1.203	0.129	-0.757, 1.156
	8 weeks	-0.451	-2.723, 0.574	-0.075	-1.312, 1.032	0.477	-0.298, 2.182
Fat mass (kg)	4 weeks	-0.112	-1.729, 1.241	-0.051	-2.069, 1.787	0.160	-1.264, 2.097
	8 weeks	-0.830	-3.211, -0.287	-0.009	-2.022, 1.971	0.224	-1.188, 2.408

Note. Pooled statistics following multiple imputation. P-PBR = partner with pair-based refund, P-IR = partner with individual refund, I-IR = individual with individual refund

Table S7: Regression statistics for all anthropometric measures for experimental condition comparisons

		P-PBR vs. P-IR B (SE)	P-PBR vs. I-IR B (SE)	P-IR vs, I-IR B (SE)
Weight (kg)	4 weeks	-0.639 (0.56)	-0.457 (0.59)	0.175 (0.44)
	8 weeks	-0.968 (0.76)	-2.052* (0.76)	-1.097 (0.61)
Body Mass Index	4 weeks	-0.203 (0.21)	-0.126 (0.22)	0.079 (0.16)
	8 weeks	-0.320 (0.28)	-0.716* (0.29)	-0.396 (0.23)
Percent body fat	4 weeks	0.142 (0.67)	-0.853 (0.74)	-0.902 (0.61)
	8 weeks	-2.105** (0.71)	-2.425* (0.99)	-0.233 (0.82)
Fat Mass (kg)	4 weeks	-0.031 (0.97)	-0.742 (1.00)	-0.614 (0.88)
	8 weeks	-1.712* (0.78)	-2.357** (0.76)	-0.625 (0.74)
Muscle Mass (kg)	4 weeks	-0.502 (0.53)	0.073 (0.64)	0.653 (0.61)
	8 weeks	1.185* (0.55)	0.382 (0.86)	-0.767 (0.74)
Visceral Fat Rating	4 weeks	-0.428 (0.26)	-0.376 (0.26)	0.023 (0.23)
	8 weeks	-0.745 (0.25)	-0.933*** (0.23)	-0.207 (0.24)
Degree of Obesity	4 weeks	-0.748 (0.78)	-0.952 (0.85)	-0.182 (0.75)
	8 weeks	-0.857 (1.01)	-3.831** (1.171)	-2.950* (1.15)

Note. Pooled statistics following multiple imputation. For all regressions, the conditions were coded as 1 vs. 0. P-PBR = partner with pair-based refund, P-IR = partner with individual refund, I-IR = individual with individual refund *p < .05 **p < .01 ***p < .001

Table S8: Cohens d and 95% confidence intervals for primary outcome measures for experimental condition comparisons

		P-PBR vs. P-IR		P-PBR vs. I-IR		P-IR vs. I-IR	
		Cohens d	95% CI	Cohens d	95% CI	Cohens d	95% CI
Weight (kg)	4 weeks	-0.382	-1.777, 0.500	-0.255	-1.636, 0.723	0.123	-0.693, 1.043
	8 weeks	-0.424	-2.536, 0.599	-0.894	-3.588, -0.516	-0.571	-2.294, 0.100
Fat mass (kg)	4 weeks	-0.011	-2.144, 2.083	-0.239	-2.888, 1.403	-0.212	-2.495, 1.267
	8 weeks	-0.716	-3.341, -0.084	-1.010	-3.901, -0.814	-0.258	-2.174, 0.925

Note. Pooled statistics following multiple imputation. P-PBR = partner with pair-based refund, P-IR = partner with individual refund, I-IR = individual with individual refund

Required sample size for fully powered trial

Based on our pilot study, the P-PBR intervention appeared to be particularly promising. Thus, in a fully powered trial, we would want to examine the effect of this strategy relative to a comparison group. If the trial was powered to detect a significant difference between the two conditions (at $p < .007$, 2-tailed, i.e., $p = .05 / 7$ (the number of measures that we incorporated within the pilot trial)) on weight loss ($d = .451$), with 80% power, we would plan to recruit 250 participants. To detect a significant difference between these groups on reductions in fat mass ($d = .83$), only 78 participants are required.

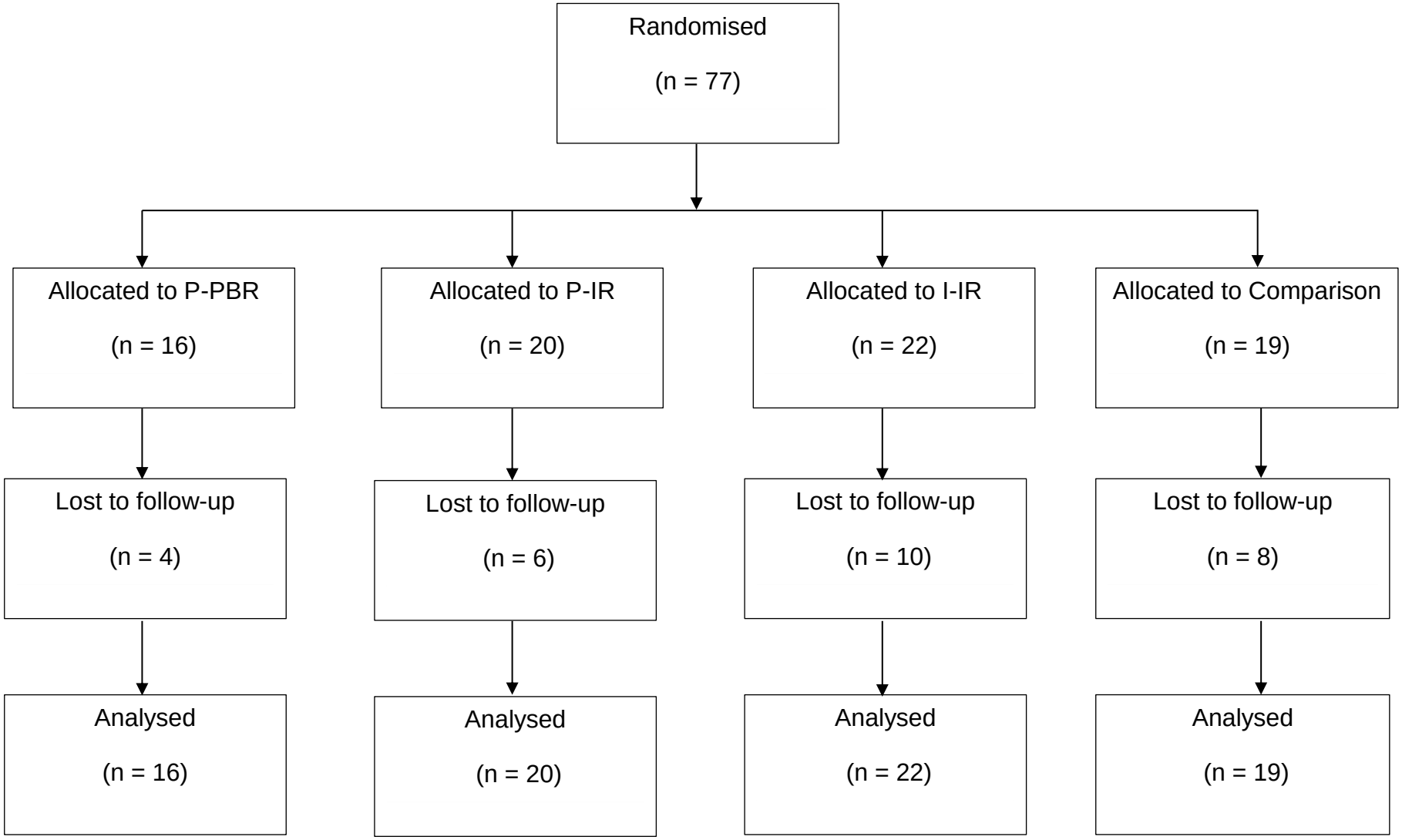

Figure S1. Participant Flow Diagram