Personal, social and environmental mediators associated with increased recreational physical activity in women and girls in the Kingdom of Tonga

Abstract

Background

The purpose of this paper is to identify personal, social, and environmental mediators of recreational physical activity in a 6-month netball-based intervention for women and girls in Tonga.

Methods

Tonga Netball's 'low-engagement village program' was implemented in 10 villages and aimed to increase recreational physical activity levels in women and girls through a comprehensive structured community-level netball program addressing key barriers to participation. In a mixed methods approach these mediating barriers were identified through qualitative interviews based on the socio-ecological model. Quantitative measures for mediators and recreational physical activity were then developed and data from 301 women and girls was collected. Standard mediation analyses methods were then applied.

Results

Program participation appeared to significantly increase physical activity levels. Statistically significant personal mediators were body issues, preferring competitions, and clothing. Social mediators were support from sports council, community leaders, friends and Church. Environmental mediators were travel time, and access to balls, bibs and umpires.

Conclusion

A comprehensive community-level program addressing key participation barriers can increase recreational physical activity amongst women and girls in Tonga. Triangulating these results with mediation analyses of variables on the causal pathway can strengthen our

understanding of causation and inform funding prioritisation for critical program components in similar contexts.

INTRODUCTION

The World Health Organisation (WHO) estimates 41 million people die annually from non-communicable diseases (NCDs), the equivalent to 71% of global mortality [1]. Cardiovascular diseases account for the majority of the NCD burden, causing 17.9 million deaths annually, followed by cancers (9.0 million), respiratory diseases (3.9million), and diabetes (1.6 million) [1]. Tobacco use, the harmful use of alcohol, unhealthy diets and physical inactivity are the four primary risk factors for NCDs [1]. Physical inactivity is the fourth leading risk factor for global mortality, contributing to over 5 million deaths per year [2]. In addition to being an independent risk factor for NCDs, physical inactivity also contributes to other risk factors, including hypertension, hyperlipidaemia, overweight/obesity and poor mental health [3]. Over 85% of "premature" deaths from NCDs occur in low-and middle-income countries (LMICs) [1 4 5]. One of those countries is the Kingdom of Tonga, a Pacific Island nation with a population of just over 108,000 [6]. In Tonga, the prevalence of obesity and overweight are 67.6% and 90.7% respectively, and 98.7% of the population are at high or moderate risk of NCDs [7]. Data from the 2014 WHO STEPS Surveillance report for Tonga indicates that women only participate in an average of 8.2 mins/day of recreational physical activity, which was a quarter as much as Tongan men [7]. Further to this, data indicates that the physical activity of Tongan women is predominantly completed in the vocation (71.5 mins/day) and transport (32.1 mins/day) domains [7]. The Kingdom of Tonga has increased investment in prevention policy to curb their NCD epidemic. This includes the establishment of the Tonga Health Promotion Foundation, the first independent health promotion body in the Pacific islands, and the implementation of the Tonga National Non-Communicable Disease Strategy 2015-2020 [8]. Tonga's diplomatic partners have assisted in this investment, with a large proportion coming from Australia and New Zealand. For example, the Australian Government has invested

AUD $10 million since 2015 through the Tonga Health Systems Support Program, aimed at improving community health services and delivering preventative health measures targeting NCD rick factors [9]. Australia also provides funding through the 'Pacific Sports Partnerships' (PSP) program [10 11]. PSP is the Australian Government's sport for development program, that since 2009 has contributed over AUD $39 million to 15 sports across 9 Pacific Island countries to design programming targeting health, social and diplomacy outcomes. One of those Pacific Islands is Tonga, where the PSP program provides funding to five national sporting federations to design and implement sport-based physical activity (PA) programming, which aims to address the primary risk factors associated with NCDs, particularly physical inactivity [11 12].

For interventions to be effective in achieving a sustained increase in PA, the design stage is a critical component, as previous evaluation results have been inconclusive [13-15]. A previous suite of reviews has found that different face-to-face and remote PA interventions had a variable effect on PA behaviour [16-18]. Further to this, a review of mediators of PA behaviour change [19] included 22 eligible studies, half of which failed to find an intervention effect. A more recent systematic review of mediators for PA behaviour change concluded that 'many of the included interventions were not effective for changing targeted mediators' [20]. More specifically, it has been argued that although there is a clear link between PA and positive health outcomes [21], the low efficacy and effectiveness of some programs may be due to a lack of knowledge regarding the actual mechanisms that lead to these outcomes [22]. This is of particular pertinence in LMICs such as Tonga, with a population of relatively physically inactive women [7], and where the efficient allocation of limited health resources is paramount. In 2013, member states of the WHO agreed to a 10% relative reduction in the prevalence of insufficient PA by 2025. This agreement was one of the nine global targets in the WHO Global Action Plan for the Prevention and Control of NCDs 2013-2020 [23]. A progress article

published in 2018 found that the average change across all of 65 countries (including Tonga) was less than 0·01%, meaning, 'if current trends continue, the 2025 global PA target will not be met' [24]. The report concluded that 'policies to increase population levels of PA need to be prioritised and scaled up urgently'. Therefore, current strategies and policies are inefficient at increasing PA, and mediation studies are crucial for improving these strategies by generating evidence of the underlying mechanisms for behaviour change in different contexts and populations.

Therefore, the purpose of this study is to apply a mixed methods approach to identifying personal, social, and environmental mediators for increasing PA through a 6-month sport-based PA intervention for women and girls in Tonga.

METHODS

The study design has been adapted from a previously published protocol [25].

Intervention design

In 2016, the Tonga Netball Association, supported by Netball Australia, was funded through the Australian Government's PSP Innovation Fund to trial a comprehensive approach to engaging women and girls in recreational PA through netball. Netball is a ball sport played by two opposing teams of 7 players each. Each team attempts to score goals by passing a ball down a court (usually a 30 by 15 metre rectangular space) and throwing it through raised goal rings at either end. Netball is predominantly played by women, who typically wear a skirt and top with lettering on the back that denotes their position on the court [26]. The 'low-engagement village program' aimed to increase PA levels of women and girls in villages with limited

access or opportunity for recreational PA, through a comprehensive community netball program addressing key barriers/facilitators to participation. These mediators for participation were identified through pre-intervention interviews with key stakeholders (program coordinators, funders, community leaders, participants) during the formative evaluation stage [27]. The initial interviews were conducted with previous contacts of Netball Australia and snowball sampling was then used across the different stakeholder types until saturation was reached. Data collection in this phase used the socio-ecological model for PA to guide the design of semi-structured interview questions [28]. Specifically, the interview guide examined intrapersonal, interpersonal, social norms, and physical environment factors associated with women and girls participating in recreational PA. The interviews were conducted by the authors of this paper and included 17 women and 3 men. The data were compiled in country and an explorative thematic analysis was completed by the authors of this paper in consultation with key personnel from both the local delivery agency and the funding body. The program was implemented in 10 villages identified in consultation with the Ministry of Internal Affairs, Tonga Health and the Tonga Netball Association as accessible population groups with minimal previous exposure to netball and low participation in organised physical activity. The program included the following components:

- Buy-in: engaged the Tongan Government, town officers, sports councils and church leaders in the design stage to ensure 'buy-in' at the community level.
- Capacity building (management): identified and trained a local netball focal point in each target village to facilitate programming.
- Capacity building (skill development): Delivered coaching and umpiring workshops to a junior local focal point in each village.

- Funding: provided funding to local focal points for petrol and administrative expenses associated with programming.
- Infrastructure: negotiated the use of a common community space with town officers in each village, marked out a netball court and erected goal posts.
- Equipment: distributed netball equipment (bibs, balls and bags and whistle) through local focal points
- Infrastructure: negotiated the use of a common community uncovered outdoor space with town officers in each village, marked out a netball court and erected locally constructed basic goal posts.
- Communication: held weekly phone calls with each focal point and undertook regular 'spot checks' to monitor progress.
- Competition: designed a structure to integrate target villages into national netball competitions. Specifically, target villages started in a separate grade participating amongst themselves, with a promotion/relegation system potentially allowing villages to progress up into top tier competitions.

Study design

The study was quasi-experimental with pre-post measures of the outcomes of interest and identified mediators taken at baseline in April and 6-months after the program started, which corresponds with the local dry season. Due to logistical, ethical and funding limitations, the inclusion of a control group (e.g. control village) was not possible. Therefore, the researchers used the qualitative data collected during the intervention design phase to develop a logic model and relevant quantitative measures as part of a process evaluation that enabled mediation analysis and to further substantiate claims of causation from the intervention on the

primary outcome of total recreational PA.

Participant selection

Intervention participation was open to all women and girls in the participating communities. Data were collected from women within the participating villages. Streets in each village and then households on each street were selected randomly to select study participants. If there were no women home in the selected households, the data collectors returned at a later time on up to three occasions before another household on that street was randomly selected. The selection of study participants was completely independent of the netball program delivery. This was designed to capture the broad impact of the netball program on the village, rather than just focus on women known to be participating.

The women in this study were aged 18-64 years (mean= 32.25, SD= 9.92). All were from the most populous island Tongatapu, 96% had completed high school as their highest education level, 80.1% were homemakers, 10% were unemployed and 4% were students.

Measures

The researchers developed quantitative indicators for each of the identified mediating factors. The data collection instrument was translated into Tongan by a local translation team and back translated into English for quality control. Questions were then pre-tested for face validity with 15 Tongan participants from various demographics and further refined accordingly. The English version of the final measures are shown in Table 1.

Table 1. Independent variable, dependent variable and mediator measures and their associated data collection instrument.

Measure	Question
PA (dependant variable)	Recreational component of the global PA questionnaire (GPAQ).
Netball participation (independent variable)	Total numbers of times per week the participant played netball (including competition, practice and social play)
Body issues	I am worried about playing netball because of my body…(strongly disagree, disagree, neutral, agree, strongly agree)
Low skill level	I am worried about playing netball because I don't have the right clothes…(strongly disagree, disagree, neutral, agree, strongly agree)
Preferring competitions over social sport	I prefer netball programs to be focussed on preparing for competitive tournaments…(strongly disagree, disagree, neutral, agree, strongly agree)
Don't have exercise clothing	I am worried about playing netball because I don't have the right clothes…(strongly disagree, disagree, neutral, agree, strongly agree)
Support (sports council, town officers, community leaders, Church, friends, family, men (family).	How supportive are the following people of you playing netball?...(very unsupportive, unsupportive, neutral, supportive, very supportive)
Support from Tonga Netball	The Tonga Netball Association is supportive of our village…(strongly disagree, disagree, neutral, agree, strongly agree)
Confidence in village to self-organize	How confident are you that members of your community can independently organise netball activities? (not confident to confident on a 100-point single item scale)

Presence of other adults participating	There are lots of adults in my community who play netball regularly…(strongly disagree, disagree, neutral, agree, strongly agree)
Travel time	Think about the netball activity you do the most. How long does it take you to get there? ...(less than 5 minutes, 5-9 minutes, 10-14 minutes, 15-19 minutes, 20-24 minutes, 25-29 minutes, 30 minutes or more, N/A)
Access to balls and bibs	We have easy access to balls and bibs in my village when we want to play netball…(strongly disagree, disagree, neutral, agree, strongly agree)
Village netball organiser	There is someone in my community who is good at organising netball…(strongly disagree, disagree, neutral, agree, strongly agree)
Access to umpires	We have good netball umpires when we play…(strongly disagree, disagree, neutral, agree, strongly agree)
Access to court	Where do you usually play netball in your village?... (permanent space set aside, open area where we can put goal posts, don't have anywhere)
Knowledge of rules	How well do you know the rules of netball?... (I don't know any of the rules, I know some of the rules, I know most of the rules, I know all the rules)

Data collection

Three local data collectors were trained by researchers prior to baseline measures, with repeat training conducted again prior to data collection at 6-months. Data were collected using iPads™ with iSurvey™ software installed. Data were collected from approximately 30 women in each of the ten villages, and in total, data were collected from 301 women at baseline, and 274 at 6-months.

Data analysis

The GPAQ data was scored according to the published analysis guide. All responses to the items with Likert scales were treated ordinal data on a linear scale and responses on the visual analogue scales were treated as continuous variables [29]. The data were analysed with SPSS version 24. Descriptive statistics were used to calculate mean scores for each variable at baseline and 6-months in Table 2. A paired-samples T-test was used to calculate change scores and confidence intervals in Table 2. To assess for mediation, we used the method devised by Baron and Kenny [30] depicted in Figure 1.

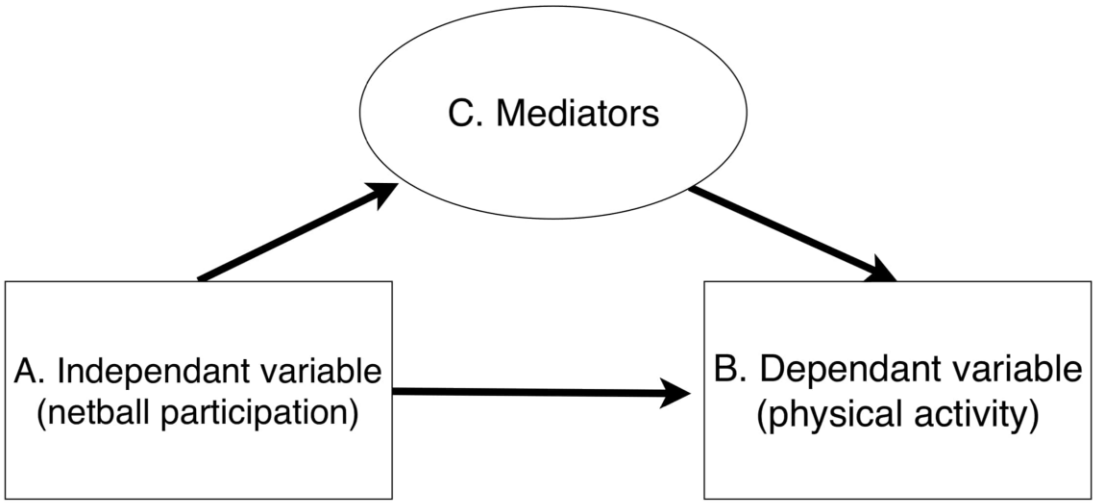

Figure 1. Method of mediation analysis devised by Baron and Kenny (1986).

This method follows four steps:

1) The first step was to establish an association between the independent variable (e.g. netball participation) and the dependent variable (e.g. PA) (path A to B in Figure 1). A regression model was used to test and estimate the effect of the netball participation on PA. The association was controlled for age and socio-economic status (SES). It was not necessary to control for gender as all participants were women.

2) The second step was to establish a relationship between netball participation and potential mediators (path A to C). A linear regression model was used for each mediator (controlling for age and SES).
3) The third step of mediation is separated into two parts:

- The first part is to establish if potential mediators were associated with PA, controlling for baseline (path C to B), controlling for age and SES.
- The second is to examine the association between netball participation and PA, while controlling for mediators, age and SES (path A to B controlling for C). This determines if the relationship between the netball participation and PA was substantially reduced when controlling for potential mediators.

4) The fourth step uses the Sobel test, which determines whether the reduction in the relationship between netball participation and PA was statistically significant. The Sobel test uses a formula (z-value = $ab/\sqrt{(b^2s_a{}^2+a^2s_b{}^2)}$ in which a = the path from netball participation to the mediator; s_a = the standard error of a, b = path from the mediator to PA; s_b = standard error of b) [31].

Ethical approval

This study was approved by the La Trobe University Human Research Ethics Committee (13-073). Approval to evaluate the 'low-engagement village program' was also granted by Netball Australia, Tonga Netball Association, as well as village elders and community leaders of villages/towns included in this evaluation.

RESULTS

The first step of mediation is to establish an association between the independent variable

(netball participation) and dependent variable (PA). When the netball participation change scores were compared with the PA change scores, a significant effect was identified - $F(3, 273) = 70.807$, $\beta = 0.651$, $p = <0.001$.

Table 2. Mean values for pre-test, post-test and change scores for PA, netball participation and mediators.

Variable	**Range**	**Baseline**	**Follow-up (6-months)**	**Change**	
				Scores (std dev)	Confidence intervals
Physical activity		18.16 (63.037)	421.31 (223.650)	403.339 (242.628)	374.483 to 432.196
Netball participation		0.02 (0.294)	4.10 (1.291)	4.080 (1.296)	3.926 to 4.234
Individual mediators					
- Knowledge of netball rules	1-4	1.29 (0.534)	1.98 (0.217)	0.701 (0.572)	0.633 to 0.769
- Body issues	1-5	1.44 (0.572)	1.43 (0.566)	0.007 (0.816)	0.090 to 0.104
- Low skill level	1-5	1.67 (0.935)	1.53 (0.790)	0.157 (1.183)	0.016 to 0.298
- Prefer competitions over social sport	1-5	1.78 (0.996)	2.20 (1.435)	0.416 (1.796)	0.202 to 0.630
- Inappropriate clothing	1-5	1.51 (0.641)	1.47 (0.664)	0.040 (0.919)	0.069 to 0.149
Interpersonal (social) mediators					
- Sports council (support)	1-5	2.99 (0.829)	4.37 (0.623)	1.416 (1.202)	1.273 to 1.559
- Town officers (support)	1-5	3.63 (0.860)	4.65 (0.574)	1.036 (1.023)	0.915 to 1.158

- Community leaders (support)	1-5	2.73 (0.937)	4.26 (0.590)	1.555 (1.195)	1.413 to 1.697
- Church (support)	1-5	2.47 (1.223)	4.22 (0.537)	1.763 (1.382)	1.598 to 1.927
- Friends (support)	1-5	2.64 (1.401)	4.39 (0.552)	1.774 (1.404)	1.607 to 1.941
- Family – living with (support)	1-5	2.55 (1.372)	4.43 (0.643)	1.891 (1.493)	1.713 to 2.068
- Men in your family (support)	1-5	2.30 (1.199)	4.39 (0.671)	2.077 (1.387)	1.912 to 2.242
- Tonga Netball (support)	1-5	2.50 (1.240)	4.20 (0.482)	1.675 (1.391)	1.510 to 1.841
- Confidence in village to self-organize	1-100	28.25 (22.942)	75.80 (9.853)	46.354 (24.352)	43.458 to 49.250
- Presence of other adults participating	1-5	2.68 (1.376)	4.04 (0.447)	1.361 (1.556)	1.176 to 1.546
Physical environmental mediators					
- Travel time	1-8	4.70 (3.494)	2.08 (1.040)	2.398 (3.799)	1.946 to 2.850
- Access to balls and bibs	1-5	1.81 (0.872)	3.97 (0.448)	2.186 (1.015)	2.065 to 2.307
- Village netball organizer	1-5	2.48 (1.282)	3.48 (0.965)	0.996 (1.525)	0.815 to 1.178
- Access to umpires	1-5	1.93 (0.970)	3.33 (1.014)	1.427 (1.636)	1.232 to 1.622
- Access to court/open field/none	1-3	2.58 (0.534)	1.56 (0.497)	0.996 (0.457)	0.942 to 1.051

The second step of mediation was to examine the association between treatment condition (netball participation) and changes in hypothesized mediators. As shown in Table 3,

mediators that failed the second step (i.e. not statistically significant) were low skill level, support from Tonga Netball Association, having confidence in the village to self-organise and the presence of other adults participating in netball.

Table 3. Effect of netball participation on mediator variables. Highlighted mediators failed the second step of mediation and were removed from further analysis.

Variable	**Beta**	**p-Value**	**Unstandardized B**	**Confidence interval**
Individual mediators				
- Knowledge of netball rules	0.160	0.008	0.071	0.019 to 0.123
- Body issues	0.279	<0.001	0.176	0.103 to 0.248
- Low skill level	0.029	0.639	0.026	-0.083 to 0.135
- Prefer competitions over social sport	0.432	<0.001	0.599	0.449 to 0.749
- Inappropriate clothing	0.319	<0.001	0.226	0.145 to 0.306
Interpersonal (social) environmental Mediators				
- Sports council (support)	0.450	<0.001	0.418	0.321 to 0.514
- Town officers (support)	0.345	<0.001	0.272	0.184 to 0.360
- Community leaders (support)	0.392	<0.001	0.361	0.261 to 0.462
- Church (support)	0.308	<0.001	0.328	0.208 to 0.448

- Friends (support)	0.299	<0.001	0.324	0.201 to 0.447
- Family – living with (support)	0.342	<0.001	0.394	0.265 to 0.524
- Men in your family (support)	0.274	<0.001	0.294	0.171 to 0.416
- Tonga Netball (support)	-0.117	0.052	-0.126	-0.253 to 0.001
- Confidence in village to self-organize	-0.016	0.789	-0.306	-2.556 to 1.944
- Presence of other adults participating	0.062	0.303	0.075	-0.068 to 0.218
Physical environmental mediators				
- Travel time	0.288	<0.001	0.844	0.508 to 1.181
- Access to balls and bibs	0.327	<0.001	0.256	0.169 to 0.344
- Village netball organizer	0.271	<0.001	0.319	0.183 to 0.455
- Access to umpires	0.401	<0.001	0.506	0.369 to 0.643
- Access to court/open field/none	-0.157	0.010	-0.055	-0.097 to -0.014
- Knowledge of netball rules	0.160	0.008	0.071	0.019 to 0.123

The third step of mediation is shown in Table 4, and is separated into two parts:

1) The first is to establish if the mediators were associated with PA, controlling for baseline (first 4 columns).
2) The second is to examine the association between exposure and outcome variables, when controlling mediators (last two columns).

Table 4. Effect of mediator variables on PA controlling for baseline; and the association between exposure and outcome variables, when controlling mediators. Highlighted mediators failed the third step of mediation and were removed from further analysis.

Variable	**Beta**	**p-Value**	**Unstandardized B**	**Confidence interval**	**Beta Exposure and outcome controlled for mediator**	**p-value**
Individual mediators						
- Knowledge of netball rules	0.027	0.561	7.953	-18.923 to 34.828	0.647	<0.001
- Body issues	0.300	<0.001	61.729	43.939 to 79.519	0.568	<0.001
- Prefer competitions over social sport	0.392	<0.001	36.706	28.472 to 44.939	0.482	<0.001
- Inappropriate clothing	0.170	<0.001	31.044	14.036 to 48.052	0.597	<0.001

Interpersonal (social) mediators						
- Sports council (support)	0.311	<0.001	43.508	29.946 to 57.070	0.511	<0.001
- Town officers (support)	0.085	0.083	14.031	-1.831 to 29.893	0.622	<0.001
- Community leaders (support)	0.244	<0.001	34.286	20.945 to 47.626	0.556	<0.001
- Church (support)	0.149	0.002	18.105	6.621 to 29.589	0.605	<0.001
- Friends (support)	0.121	0.012	14.474	3.207 to 25.742	0.615	<0.001
- Family – living with (support)	0.083	0.088	9.367	-1.389 to 20.124	0.623	<0.001
- Men in your family (support)	0.045	0.345	5.498	-5.933 to 16.929	0.639	<0.001
Physical environmental mediators						
- Travel time	0.249	<0.001	11.024	7.074 to 14.975	0.580	<0.001

- Access to balls and bibs	0.130	0.008	21.452	5.679 to 37.226	0.609	<0.001
- Village netball organizer	0.061	0.196	6.749	-3.511 to 17.009	0.635	<0.001
- Access to umpires	0.218	<0.001	22.345	12.479 to 32.211	0.564	<0.001
Access to court/open field/none	-0.029	0.534	-10.597	-44.089 to 22.895	0.647	<0.001

The fourth step was to determine whether the reduction was statistically significant. The Sobel test was used and results are presented in Table 5. [31].

Table 5. Sobel test for mediation. No variables failed the fourth test of mediation.

Variable	**a**	**Sa**	**b**	**Sb**	**z-Value**	**p-Value**
Individual mediators						
- Body issues	0.176	0.037	61.729	9.036	3.904	<0.001
- Prefer competitions over social sport	0.599	0.076	36.706	4.182	5.864	<0.001
- Inappropriate clothing	0.226	0.041	31.044	8.639	3.010	0.003
Interpersonal (social) mediators						
- Sports council (support)	0.418	0.049	43.508	6.888	5.076	<0.001

- Community leaders (support)	0.361	0.051	34.286	6.776	4.116	<0.001
- Church (support)	0.328	0.061	18.105	5.833	2.688	0.007
- Friends (support)	0.324	0.062	14.474	5.723	2.277	0.023
Physical environmental mediators						
- Travel time	0.844	0.171	11.024	2.007	3.671	<0.001
- Access to balls and bibs	0.256	0.045	21.452	8.012	2.423	0.015
- Access to umpires	0.506	0.070	22.345	5.011	3.795	<0.001

DISCUSSION

The purpose of this study was to examine the impact of a netball intervention for women and girls in Tonga on recreational physical activity participation and to identify personal, social, and environmental mediators associated with any observed changes over a 6-month period. Our results clearly suggest that the intervention had a large impact on the netball participation levels in the participating villages and that this correlated with large changes in recreational physical activity levels. Of particular note, is that prior to the intervention, many of the women in the villages were not participating in any recreational physical activity and after 6 months the mean volume of recreational physical activity was more than double the global recommendations for total physical activity [21]. Despite the cross-sectional nature of these findings, statements of causation can be triangulated by the significant results in the mediation analyses of qualitatively identified determinants for netball and recreational physical activity participation. The implications of the mediation results are considered in

more detail below.

Personal mediators

The quantitative analyses indicated that addressing body image issues is a critical component of the program. Body image concerns have been widely recognized as both a barrier and reason for physical activity participation [32]. This question identified concerns from the women about the ability of their bodies to cope with the rigours of playing netball as well as potential public embarrassment about their bodies. This aligns with a substantial evidence base that identifies low levels of physical self-efficacy as a major barrier to participation in recreational physical activity, particularly for women [33-35]. Self-consciousness about body image also links with the finding that having inappropriate clothing was a significant mediator for participation. Clothing that enables women to move comfortably and also covers their body in a way that is culturally sensitive to local norms has been previously identified as a critical factor in encouraging physical activity [36-38]. This is often addressed through the provision of team uniforms in sport-for-development programs that have a competitive element, which appeared to be another important mediator in our analyses. This finding is in contrast to the majority of the existing evidence , which indicates that women are often less motivated by competitive physical activity endeavours and may actually be deterred by competitive sport as a form of physical activity [37 39 40]. However, in a context where women's sport and physical activity has previously received little support and the local population have limited previous reference points for non-competitive recreational physical activity, we have interpreted this finding as an indicator that women want their desire to participate in netball to be taken seriously. The vast majority of sport-for-development interventions in similar settings also have a competitive component because a non-competitive approach to sport is

initially conceptually foreign to the local communities [41]. Adding to this, the Pacific Islands are known to be highly passionate about sport, and their respective countries being represented through sport on the global stage. It is therefore not unrealistic to draw from this that this cultural aspect would likely filter down into grassroots sport in these settings. This finding can be leveraged in future programming by gradually increasing the competitive aspects of an intervention (e.g. training, inter-village competitions), and eventually integrating grassroots programs into community and national pathways for each sport.
The finding that low skill level was not a significant mediator is consistent with previous studies that suggest this is more important for men than women [42]. Specifically, the physical self-efficacy for women tends to be more related to their body image as described above, while boys focus more on skill level and sporting success. Similarly, knowledge of the rules was not a significant mediator in our study. Although developing sports knowledge and skills will always be a key component of "sport-plus" sport-for-development interventions, based on our results it would appear that a large focus on skill development may not be as critical as the other factors described above when aiming to increase participation in recreational physical activity.

Interpersonal (social) environmental mediators

Our findings that support from sports councils, community leaders, Church leaders, and friends were mediators of recreational PA in women and girls in Tonga are strengthened through insights from Tongan society. Firstly, the findings can be partially explained by Geert Hofstede's cultural dimensions theory, in which the concept of collectivist v individual cultures is explained [43 44]. Specifically, collectivism is a social value characterized by an emphasis on cohesiveness among individuals and the prioritization of the group (or country)

over the individual. Whilst no collectivism score is available for Tonga, that of neighbouring Pacific Island country Fiji is 14, described as 'incredibly low', meaning Fiji is considered a strongly collectivistic society [45]. Therefore, with geographical and cultural parallels, Tonga can likely be characterized as a collectivist culture, and has been described so outside of academic literature. In these settings with tightly connected social structures, gaining support from hierarchical social, governance and religious leaders and organisations is key to securing the buy-in of participants in programming. Secondly, Tonga maintains a strong community focus (e.g. sharing and giving of resources is commonplace), protection of culture (e.g. Tongans have a word for 'their way' - *anga fakatonga*) and prioritization of family (e.g. property cannot be sold in Tonga but is passed down family lines). Further to this, 98% of Tongans identify as Christian, with Sunday a day of church and rest enforced by law. Therefore, the decision to participate in recreational PA is likely to be strongly influenced by church, community and social interaction, as these are not seen as separate domains. This indicates that community and church leaders are crucial stakeholders in the design stage of future PA interventions in Tonga.

As a side note, our findings that support from men didn't mediate PA is also notable, but unsurprising. Gender is the primary determinant of an individual's position in the social and familial hierarchy in Tonga. Women are highly respected, as demonstrated through familial interactions. Furthermore, the lack of significance for several of the other interpersonal mediators (e.g. town officers, immediate family, other adult community members), which were identified during the formative qualitative interviews, is indicative of the heterogeneity of the broader evidence in this area. Specifically, there is evidence that personal self-regulation mediators have the strongest link to participation [19], with a more variable and often negligible contribution from interpersonal mediators [34].

Physical environmental mediators

A systematic review of mediators of PA [33] found significant mediation for PA by perceived environmental barriers. We found that access to balls and bibs was a critical mediating factor for participation. Whilst this may seem like an obvious finding, when taken in the context of the large change in netball participation that did occur during the program, this result provides an important reminder of the scarcity of basic sports equipment in low-income settings and the potential impact of providing them in local communities. Similarly, the significance of travel time as a mediator is consistent across the literature [38 46], but may be particularly pertinent in socio-economic settings where there are limited public transport options and private transport is often limited to walking. This finding highlights the value of sport-for-development programs investing in the provision of transport to/from activities for the participants and support personnel. This includes umpires, whose provision was also identified as a significant mediator for participation. We interpret this finding as a need for guidance when learning the rules of a new sport, which is also linked to the embedded desire for an organized competition as discussed previously. It is possible that as netball becomes more widely understood and accepted in the participating villages, organic recreational play that is non-competitive and does not require an umpire may become more common [41].
The non-significant findings that indicated a village netball organizer and access to a dedicated netball space may not be important mediating factors for participation were unexpected and warrants further investigation. It is possible that the relatively small geographical spread of the participating villages that enabled regular access by dedicated staff from Tonga Netball diminished the relative importance of having local netball organisers, who were often from neighbouring villages or worked elsewhere. The rural setting of the participating villages also meant that there was an abundance of non-specific green space

cleared and available for recreational physical activity, which may have undermined the need for a dedicated netball court. In any case, we interpret these finding with caution and advise against any major changes to these components of the delivery model given the emerging evidence for the role of local champions and dedicated recreational space in the sport-for-development sector [47].

Strengths and Limitations

While our results produced key findings for recreational PA policy and practice in an under researched (e.g. LMIC) but overburdened (e.g. low PA and high NCDs) setting, key strengths and limitations should be considered. Firstly, the tight partnership between practitioners and evaluators was a strength in ensuring both evidence-based program design, and appropriate rigor in study design. Specifically, the embedding of a formative evaluation into program design was crucial to identify and address key program barriers prior to implementation. The subsequent study design allowed for these barriers to be examined more rigorously, analysed for mediation, and used to produce results crucial for future program development in this setting. We used the standardised global physical activity questionnaire (GPAQ) to measure physical activity. However, despite other measures not being globally standardised, we undertook significant effort to address this. This included measures being translated into Tongan, as well as being back translated into English, to ensure cultural adaptation and clarity of content. Further to this, measures were pretested with 15 Tongan participants, and refined accordingly.

The lack of a control group is a weakness in this study. This was primarily due to ethical considerations of using funding in this way, in a setting with already minimal financial resources. Despite this, our mixed methods approach of conducting qualitative interviews to inform the development of a logic model and subsequent mediation metrics enabled the

triangulation of our pre-post measures for the primary outcome of recreational PA participation. Further to this, pragmatic program design (with formative evaluation), study design and data collection, such as that presented in this paper, provides real world evidence of program effect and key mediating factors for interventions in settings that have a critical need for evidence to improve policy and practice.

CONCLUSION

We identified key mediators of recreational physical activity amongst women and girls in Tonga, producing key insights for practice and policy. Specifically, programs need to be comprehensive, with a built-in formative evaluation proactively addressing barriers across multiple levels of the socio-ecological model prior to implementation. This 'co-creation' design between local program implementing organisations, foreign design organisations and evaluation experts is crucial in settings with limited resources for refining programs in the future. Current evidence shows physical activity interventions are often ineffective, efforts to address global physical inactivity have been stagnant, and 85% of global non-communicable disease burden occurs in low- and middle-income countries like Tonga. Therefore, mediation studies revealing the underlying mechanisms for success or failure, such as these, are crucial for designing and scaling up effective programming and policies.

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