

# Participant profile and impacts of an Aboriginal healthy lifestyle and weight loss challenge over four years 2012-2015

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Positive health impacts from small-scale or local lifestyle behaviour change interventions for Aboriginal Australians have been demonstrated. For example, Canuto et al.<sup>1</sup> observed decreased weight, body mass index (BMI) and blood pressure among urban Aboriginal women after 12 weeks of a structured exercise and diet program. A small trial of a 12-week supervised exercise program<sup>2</sup> demonstrated improved BMI, waist and glucose metabolism measures in Aboriginal men. Although this and other short-term clinical interventions<sup>3-5</sup> have shown positive effects, and cultural aspects were incorporated, they were more focused on treatment of disease and individuals and therefore may not achieve population-level change for Aboriginal Australians. Activities of daily living or sport-focused interventions may confer greater benefits because of access, affordability and their ability to build social capital among Aboriginal Australians.<sup>6-8</sup> Team sports provide physical health and personal development opportunities and may provide a platform for community development benefits (social connection, cultural identity and life skills) through community sporting clubs.<sup>8-10</sup> Unfortunately, these seldom achieve measurable and sustained large-scale community reach, particularly for Aboriginal peoples, with barriers such as costs of transport, membership and a lack of sport infrastructure

## Abstract

**Objective:** To explore participation, consistency of demographic and health profiles, and short-term impacts across six Aboriginal Knockout Health Challenge (KHC) team-based weight loss competitions, 2012 to 2015.

**Methods:** Data comprised one competition each from 2012 and 2013 and two per year in 2014 and 2015. We compared baseline and change (pre- to post-competition) in weight, fruit and vegetable consumption, physical activity and waist circumference (baseline only) across competitions using mixed models.

**Results:** Numbers of teams and participants increased from 2012 to 2015 from 13 and 324 to 33 and 830, respectively. A total of 3,625 participants registered, representing 2,645 unique people (25.4% repeat participation). Participants were mainly female and >90% were classified obese at baseline. Baseline weight and weight lost (between 1.9% and 2.5%) were significantly lower in subsequent competitions compared with the first. Improvements in fruit and vegetable consumption and physical activity were comparable across competitions.

**Conclusion:** The KHC has increasing and sustained appeal among Aboriginal communities, attracting those at risk from lifestyle-associated chronic disease and effectively reducing weight and promoting healthy lifestyles in the short term.

**Implications for public health:** Community-led programs generated by, and responsive to, Aboriginal Australians' needs can demonstrate consistent community reach and sustained program-level lifestyle improvements.

**Key words:** physical activity, obesity, intervention, Aboriginal and Torres Strait Islander, weight loss

(facilities and sponsors) often affecting participation in Aboriginal communities.<sup>8</sup>

## Community-based lifestyle behaviour change interventions

Comparatively few community-based physical activity (PA) and nutrition interventions targeting Aboriginal

Australian adults have been evaluated.<sup>11,12</sup> Three early interventions had variations in approach (including health education,<sup>13-15</sup> environmental and policy changes<sup>14</sup>) and duration (six weeks<sup>13</sup> to a few years<sup>14,15</sup>) but demonstrated waist<sup>13,15</sup> and weight reductions,<sup>13</sup> reduced sedentary behaviour,<sup>14</sup> and increased vigorous PA.<sup>14</sup> In a review of

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PA or sport programs targeting Aboriginal and Torres Strait Islander people, MacNiven found 39 programs addressing PA or sport in adults operating in or since 2012, primarily in the grey literature. Only 25 reported any evaluation data, few are publicly available and not all include health outcomes.<sup>12</sup> Of the three including weight-related outcomes, only one was evaluated and showed significant reductions in waist circumference, weight and BMI, and significant increases in intake of vegetables and of fruit.<sup>16</sup> Together, these results suggest that effects of community-based PA interventions with Aboriginal Australians can result in modest but significant changes in risk profiles, but more evaluations are needed to build the evidence base.

### **Impact of lifestyle-related disease on Aboriginal populations**

It is clear that non-communicable chronic diseases (NCDs) continue to be leading contributors to disease burden of Australians.<sup>17</sup> They are particularly prevalent among Aboriginal and Torres Strait Islander Australians and are responsible for much of the health gap between Indigenous and non-Indigenous Australian populations.<sup>18</sup> In 2013, 29% of Aboriginal and Torres Strait Islander Australian adults were overweight and 37% were obese, these rates being 1.2 and 1.6 times higher, respectively, than in the non-Indigenous population.<sup>19</sup> Other contributors to NCD development include dietary and PA habits: 42% of Aboriginal and Torres Strait Islander adults residing in urban and regional areas consume adequate fruit, but only 5% consume the recommended vegetable intake; just over half do not meet the recommended amount of PA, comparable to non-Indigenous populations.<sup>19</sup> Smoking rates among Aboriginal and Torres Strait Islander people aged 15 and over have been estimated at 44%, 2.6 times higher than among non-Indigenous people.<sup>19</sup> For this population, 37% of the burden of disease is preventable through addressing these and other modifiable risk factors such as alcohol consumption.<sup>18,19</sup> Therefore, scaled-up community-wide program evaluations are required to build a comprehensive evidence base for NCD prevention with this population. Evaluation of scaled-up interventions is particularly important as it provides evidence that promising interventions are feasible, appropriate and effective when implemented across diverse communities or, as in the case

of the Knockout Health Challenge (KHC), across the state of New South Wales (NSW). The lag between evidence generation and implementation at scale is a major impediment to health improvement for Aboriginal people, as it denies or delays community access to effective programs.

### **The NSW Aboriginal Knockout Health Challenge**

The community-based interventions described above were not sustained over time and were relatively small-scale, and the studies evaluating them were published more than 10 years ago. More recently, the NSW Aboriginal KHC has been running team-based competitions in weight loss through PA and healthy eating in NSW, Australia, with up to 830 participants per competition ([www.nswknockouthealthchallenge.com.au](http://www.nswknockouthealthchallenge.com.au)). Community teams with 20 to 30 Aboriginal adults compete in the KHC for prize money that funds community initiatives in health, sport, nutrition or fitness. Teams are formed through existing social networks and local promotional activities and self-determine the frequency and type of activities they do, but all include one group PA training and one healthy eating activity. In 2012 and 2013, there was one 17-week competition, with two 10-week competitions in 2014 and two 12-week competitions in 2015. The Challenge has links to the Koori Knockout competition (<https://www.facebook.com/nswkko/>) and the Rugby League more generally, which promote the event. Community engagement is further strengthened through Challenge Town Committees<sup>20</sup> comprising volunteers across local government, health services and land councils who support and promote the Challenge in their local area. Further details are provided in the Supplementary Materials and elsewhere.<sup>16</sup> An initial evaluation in 2013 showed significant reductions in waist circumference, weight and BMI and significant increases in intake of vegetables and of fruit at the end of the KHC.<sup>16</sup> Given the lack of large-scale sustained interventions, in combination with a paucity of peer-reviewed studies on community-based interventions in this population—especially sport-based interventions<sup>8</sup>—we compared participation and intervention-level impacts of the KHC over four years. Specifically, we examined whether the KHC continued to attract a relevant demographic and at-risk population, the extent of complete and repeat participation, and whether short-

term impacts on participants' risk profiles were consistent and sustained across six competitions, 2012 to 2015.

## **Methods**

### **Study design and data collection**

Change in participant outcomes from baseline to completion for each competition was monitored for prize allocation and ongoing delivery of the program using single group pre-post design. Written consent allowed the use of these data for prize calculation and research purposes. This analysis used information from one KHC competition from 2012 and 2013 and two per year in 2014 and 2015. A summary of the data collected over the years 2012–2015 is shown in Table S1. Prior to each competition, participants joined a team and recorded their name, date of birth, and gender on a registration form. From 2013, self-reported current smoking status and fruit and vegetable intake (servings of each on a typical day) was recorded and, from 2014, PA (frequency in last 7 days of 20 minutes or more vigorous PA, 30 min or more of walking, and 30 min or more of moderate PA) was included using validated questions.<sup>21</sup> Starting weight (to nearest 0.1kg), height (cm), and waist measurement (cm) were measured objectively by a doctor or registered nurse and also documented on the registration form. Registration and consent forms were collated by team managers and forwarded to the event organisers. At the conclusion of the competition, participants' weights were recorded by a health professional and self-reported lifestyle risk factors via questionnaire using the same questions as at registration.

### **Participants**

Participants from teams with 20 members or more at registration were included in the analysis. A total of 3,625 participants were registered for the six competitions from 2012 to 2015, representing 2,645 unique people, as 671 (25.4%) people took part in more than one competition.

### **Data treatment and measures**

Data for the six competitions were merged, with probabilistic record matching by participant name, sex and date of birth through an independent data linkage agency (The Centre for Health Record Linkage – <http://www.cherel.org.au>). Where a range was given for health behaviours,

the lowest number was entered (e.g. 2–3 serves of vegetables was recoded as two serves) because people tend to over-estimate healthy behaviours.<sup>22–24</sup> Adequate PA was defined as three or more vigorous sessions/week; or five or more walking or moderate sessions/week; or 1–2 vigorous sessions/week and 3–4 walking or moderate sessions/week, according to previous procedures.<sup>25</sup> Fruit and vegetable intakes were also categorised for meeting current dietary recommended levels of two serves of fruit and five serves of vegetables per day.<sup>26</sup>

### Analysis

Across the six competitions, the number of teams, registrants and mean age of registrants were calculated for each competition, along with the proportion in each competition who were male/female, repeat registrants, and completers of the competition (had both start and end weight). The intraclass correlation (ICC) for the primary variable of interest (percentage weight change) within teams ranged between 0.064 (competition 6, 2015) to 0.295 (competition 1, 2012) across the six competitions, demonstrating a clear clustering effect for team, which was stronger for the early KHCs. Over all competitions, the ICC for person was 0.170.

Baseline health characteristics (weight, waist circumference, meeting minimum fruit and vegetable consumption, and sufficient PA) were compared across competitions with 2012 as the reference category for weight and waist circumference, 2013 for smoking, fruit and vegetable intake and 2014 for PA. Crossed random effects rather than nested models were used to account for the clustering of observations within person and within team because people did not uniquely nest within teams but changed teams across competitions.<sup>27</sup> Linear models were used for continuous variables, and logit models with QR decomposition were used for dichotomous outcome variables.<sup>28</sup>

To examine the consistency of short-term impacts, difference scores were calculated by subtracting baseline from post-intervention scores for each competition. Crossed random effects models on the difference scores using the same reference competitions described above were generated; differences were normally distributed so linear models were used for all outcomes. A threshold of 0.05 was used for statistical significance and all analyses were conducted using Stata 14.2 (College Station, TX, USA) and included gender and age (continuous) as fixed effects.

Ethics approval for the secondary analysis was provided by the Aboriginal Health and Medical Research Council (Project #1125/15).

## Results

### Participation over competitions

Participation and competition completion rates for the 3,625 participants (including repeat participants) are shown in Table 1.

The number of teams registering sufficient members to start the competition increased across four competitions: 2012, 2013 and the first competitions in 2014 and 2015. Second competitions in 2014 and 2015 attracted many repeat participants (almost half of those registering in 2014) with the majority of repeaters carrying over from the first to the second competitions (207/227 and 178/246, respectively). The number of unique participants for 2014 (both competitions combined) was 1,105 and for 2015 was 1,226. The completion rate dropped from almost three-quarters in the first competition in 2012 to around half to two-thirds of registrants thereafter. The majority of participants were female, and the average age of participants was 39.1 years (SD=12.5).

### Registrant profile across competitions

Participants' baseline health characteristics for the six competitions are shown in Table 2; beta coefficients with 95%CI comparing across competitions are in Supplementary Table S2.

Baseline weight, adjusted for gender and age, was significantly lower for all competitions compared with 2012 except for competition 3 (beta=-1.09 [95%CI: -2.39, 0.21], *p*=0.100) and marginally lower in competition 5 (beta=-1.27 [95%CI: -2.61, 0.08], *p*=0.065). However, all competitions attracted registrants with an average of Class 2 obesity (<https://www.cdc.gov/obesity/adult/defining.html>). The smallest significant weight loss (adjusted for age and sex) was 1.7kg (competition 3) and largest 2.8kg (competition 4), with BMI following a similar pattern of results. Starting waist circumference only differed significantly from 2012 in competition 4 (2014), by an average of 3.76cm (95%CI: -7.51, -0.01; *p*=0.049).

In terms of change in other risk factors, there were no significant differences between the first competition where this was measured and subsequent competitions in the proportion of registrants meeting PA or vegetable consumption

**Table 1: Participation in Aboriginal Knockout Health Challenges 2012 to 2015.**

Year	Challenge					
	2012	2013	2014		2015	
competition	1	2	3	4	5	6
Teams <sup>a</sup>	13	22	30	18	33	22
Registrants (start)	324	585	828	484	830	574
Repeat participants	NA	112 (19.2%)	167 (20.2%)	227 (46.9%)	231 (27.8%)	246 (42.3%)
Completers <sup>b</sup>	239 (73.8%)	379 (64.9%)	544 (65.7%)	259 (53.5%)	531 (64.0%)	323 (56.3%)
Males	89 (27.5%)	159 (27.7%)	229 (27.7%)	132 (27.3%)	237 (28.6%)	123 (21.6%)
Females	235 (72.5%)	416 (72.4%)	599 (72.3%)	352 (72.7%)	592 (71.4%)	447 (78.4%)
Age in years (SD)	38.5 (11.7)	40.1 (13.6)	39.4 (12.5)	38.5 (11.9)	38.8 (12.4)	39.0 (12.2)

Notes:

a: To be eligible to start in a competition a team must have at least 20 registered members

b: Participant had both start and end weight.

**Table 2: Participant health characteristics at start of each competition 2012-2015.**

At start of competition	Competition (year)					
	1 (2012) N=324	2 (2013) N=585	3 (2014) N=828	4 (2014) N=484	5 (2015) N=830	6 (2015) N=574
Mean weight in kg (SD)	102.2 (21.6)	98.5 (22.4)**	100.9 (22.9)	97.0 (22.9)**	97.1 (24.2)	97.2 (23.0)**
Mean BMI (SD)	37.1 (7.5)	35.7 (7.8)*	36.6 (7.7)	35.1 (7.7)**	35.4 (8.0)	35.6 (8.1)*
Mean waist in cm (SD)	115.8 (15.8)	113.3 (16.8)	115.9 (18.3)	111.0 (18.1)*	111.4 (19.3)	112.6 (18.3)
Meet fruit rec n (%)	NA	258 (47.4)	367 (57.4) <sup>†</sup>	239 (61.0)**	367 (44.3)	259 (46.8)
Meet veg rec n (%)	NA	46 (8.4)	65 (8.7)	63 (14.5)	67 (8.1)	43 (7.8)
Sufficient PA n (%)	NA	NA	416 (51.4)	231 (50.0)	460 (51.9)	264 (47.7)
Daily smoker n (%) <sup>a</sup>	NA	153 (28.7)	248 (30.0)	142 (29.3)	254 (31.3)	127 (23.4)

Notes:

\* Significantly different compared with competition 1 (compared with competition 2 for fruit, vegetables and smoking, and competition 3 for PA) at *p*<0.05,

\*\* at *p*<0.01

a: The model did not converge for current smoker; no formal comparison available.

recommendations at baseline; the latter was consistently very low with less than 10% meeting vegetable guidelines for all except one competition (Table 2). However, registrants had higher odds of meeting fruit recommendations in competitions 3 (adjusted odds ratio (AOR)=1.58; 95%CI: 1.09, 2.27) and 4 (AOR=1.92; 95%CI: 1.27, 2.92) than competition 2. Smoking rates appeared similar for the first four competitions and dropped in the last competition.

**Change compared across competitions**

Table 3 shows health characteristics at the beginning and end for each competition. Beta coefficients and 95%CI for comparisons of the magnitude of change pre- to post-competition compared with competition 1 (competition 2 for fruit and vegetable consumption and competition 3 for the PA measures) are given in Table S3.

Despite the varying competition duration across the years (see methods above), there were few discernible systematic differences in competition outcomes. The analysis showed that although short-term impacts were modest, there were consistent changes across the years in the direction of improvements in health indicators. In detail, the amount of weight lost was greatest in competition 1 whether measured by per cent weight lost, kilograms or BMI (Tables 3 and S3). Participants who completed competition 1 lost on average about 5% of their starting body weight, but the average percentage weight lost for subsequent competitions was between 1.9% and 2.5%, adjusted for sex and age (Table S3). A supplementary analysis including only new (as opposed to

repeat) registrants showed the same pattern of effects (Table S4). By contrast, the change in fruit and vegetable consumption and sessions of walking, moderate and vigorous PA were comparable across the competitions. Only in competition 6 was there a marginally higher increase in vegetable consumption compared with competition 2, when it was first measured (beta= 0.37, 95%CI: -0.03, 0.77; p=0.072).

**Discussion**

Community engagement in program design and implementation is considered a critical determinant of program effectiveness of healthy lifestyle programs for Aboriginal and Torres Strait Islander people,<sup>14,29</sup> yet few of these types of programs are evaluated and reported in the peer review literature. The KHC is an example of a community-led (and government-supported) intervention run over successive years and reaching many hundreds of Aboriginal Australians at risk of chronic disease due to lifestyle risk factors. An initial evaluation of the 2013 KHC indicated participants felt they benefitted not only physically, but also from feeling more socially connected, with improved self-esteem, reduced stress and better linkages with their local Aboriginal Medical Service.<sup>20</sup> Our study of six successive competitions during 2012–2015 extends these findings by examining temporal changes in participation and impact effect size, making this one of the few studies to examine sustainability of healthy lifestyle programs for Aboriginal Australians.

It is clear the KHC attracts and retains the interest and active participation of the target population. Increasing participation

may in part be due to efforts made by KHC organisers to incentivise, promote and adapt the intervention over time. For example, there are start-up funds for teams and free t-shirts, caps and water bottles for individual participants, a strategy found to be effective in engaging Aboriginal people in the *1 Deadly Step* program.<sup>30</sup> Moreover, the KHC is led by local Aboriginal communities and participants are local Aboriginal people. The program is promoted by the NSW Aboriginal Rugby League Knockout, which engenders team spirit according to previous research,<sup>20</sup> and prize funds can be used to support local teams joining that competition, leveraging one sport intervention with another. KHC program staff visit teams, informally gathering information about what program components work well and what needs to change. Therefore, the sustainability and growth of KHC may be due to the flexibility and adaptability required for successful intervention on complex issues in populations coping with multiple disadvantage.<sup>13,14</sup>

In years with two competitions (2014 and 2015), the second competition attracted a smaller number of participants than the first. The second competition in a year runs in the coldest months which likely contributes to the reduced participation, as previous research shows PA participation drops in colder months<sup>31</sup>; the majority of participating teams are based in regional areas, which are subject to colder temperatures and may have less access to all-weather facilities. Organisers could consider the feasibility of partnering with organisations with indoor facilities to enhance the attractiveness of the second competition in each year.

Completion rates in the KHC were highest for the first competition (74%) and subsequently were between 55% and 65%. Attrition rates among weight loss interventions in the literature vary between 23% and 90% and depend on intervention characteristics, setting, population and length of the intervention.<sup>32</sup> The vast majority of research examining attrition in weight loss interventions targets mainstream populations in intensive clinic-based programs. One community-based six-month weight loss program reported a 47% completion rate,<sup>33</sup> lower than that found here and perhaps demonstrating the strength of the group-based approach of the KHC.<sup>34</sup> Team-based weight loss has been effective in other populations,<sup>9</sup> but may be particularly effective for retention in the KHC because

**Table 3: Pre and post participant health characteristics from pre to post competition 2012–2015 and percent weight change.**

Outcome	Competition (year)											
	1 (2012) N=239		2 (2013) N=379		3 (2014) N=544		4 (2014) N=259		5 (2015) N=531		6 (2015) N=324	
% weight change	-4.7		-2.3**		-2.2**		-2.8		-2.7**		-2.6**	
	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post
Weight kg	103.0	98.1	97.2	95.0**	101.0	98.7**	95.2	92.6**	98.4	95.7**	97.0	94.5**
BMI	37.5	35.8	35.1	34.4**	36.0	35.2**	33.9	33.2**	35.3	34.4**	35.0	34.0**
Fruit serves/day	NA		1.6	2.0	1.8	2.2	1.9	2.1	1.3	1.7	1.5	1.9
Veg serves/day	NA		2.3	2.8	2.2	2.8	2.7	3.0	2.0	2.6	2.1	3.0
Walking	NA		NA		2.2	3.0	1.9	2.6	2.1	2.7	1.9	2.8
Moderate PA	NA		NA		1.6	2.5	1.7	2.4	1.6	2.2	1.5	2.2
Vigorous PA	NA		NA		1.8	2.5	1.6	2.2	1.9	2.5	1.7	2.4

Notes:  
\* Significantly different compared with competition 1 (compared with competition 2 for fruit and vegetables, and competition 3 for walking, moderate and vigorous PA) at p<0.05, \*\* at p<0.01

the format capitalises on local pride and social connections.<sup>6,35</sup> The completion rate observed for the KHC therefore fares well and may even be slightly underestimated, because completion was defined as providing both start weight and final weight, and participants may take part in KHC activities until the end but not provide a final weight. The health profile for eating, smoking and PA behaviours of registrants attracted to subsequent competitions showed no difference compared to the first competition where that behaviour was measured, but registrants weighed significantly less in competitions 2–6 compared with the first. It is unclear why; we did not observe a sustained downward trend. One possible explanation is that those who were most motivated and most in need participated in the first KHC. Despite this, around three-quarters of KHC registrants met the definition of obesity. Further, prevalence of meeting guidelines, especially for vegetable consumption, was low, demonstrating the KHC consistently attracts those at high risk of chronic disease. KHC registrants also reflect the broader Aboriginal population in terms of PA and fruit intake, although they fare somewhat better on smoking rates and recommendations for vegetable consumption.<sup>19</sup> The KHC is therefore well-targeted.

The predominance of females (up to 78%) is disproportionate to their representation in the 'at-risk' population,<sup>36</sup> but reflects other volunteer weight loss programs.<sup>37</sup> Aboriginal and Torres Strait Islander men have poor health-seeking behaviours compared to their female counterparts, for reasons ranging across cultural (e.g. traditional gender-related law) and societal (sex-specific difference in health) factors.<sup>38</sup> Introduction of measures to increase male participation in future Challenges are warranted and could include informal consultations to better understand the program needs of Aboriginal men; actively engaging more men in team management and program coordination and support roles; or enlisting male Aboriginal health workers to promote the KHC as used in other settings.<sup>39</sup>

Losing at least 5% of body weight is considered to be clinically meaningful<sup>40</sup> and while this threshold was not achieved, on average, the percentage lost is comparable with other lifestyle behaviour change programs.<sup>41,42</sup> For four competitions it exceeded 2.5%, where benefits for glycaemic measures start to improve,<sup>43</sup> despite an increasing proportion of repeat participation.

Research is mixed as to whether repeat weight loss attempts are associated with greater likelihood of weight loss.<sup>44,45</sup> Worrick et al. (1993) reported that although repeat participants in their worksite team weight loss annual competition lost weight, they also risked 'weight cycling', whereby weight lost during the competition was regained in the inter-competition period.<sup>46</sup> The 2013 KHC evaluation showed almost one-third of those followed up regained weight nine months post-competition.<sup>20</sup> Our analysis showed that the weight lost and change in diet and PA behaviours were similar whether the analysis was on all participants or confined to only those who were new to the KHC. Future research could examine within-individual patterns of weight from the end of one competition to the start of the next to further investigate inter-competition regain and maintenance and associated correlates.

KHC, despite being a 'weight loss challenge', targets other healthy lifestyle factors and showed consistent improvements across six competitions, including increased fruit and vegetable intake and increased proportion of people achieving recommended levels of PA, which benefit health. Previous epidemiological studies have shown that those who meet recommendations for PA have better health outcomes than those who do not within the same weight class.<sup>47</sup> Smoking behaviour was not a focus of the intervention until 2018, when referrals to a smoking cessation program were formally included. Future analyses may examine changes in smoking outcomes among participants.

### Strengths and limitations

Despite growing evidence for effective community-based lifestyle interventions for Aboriginal people, previous studies have been conducted in a single Aboriginal community, with one notable exception – the evaluation of the 2013 KHC. Our evaluation across six different competitions offers unique insights into program implementation at scale and under real-world conditions, addressing a gap in the intervention research evidence base.<sup>48</sup> Limitations include, first, the absence of a control group, meaning the effects observed may be unrelated to KHC participation but are unlikely in the absence of any intervention. Second, attrition rates, although comparable to other weight loss interventions, were high and those lost to follow-up may have lost less weight or not made behavioural changes, risking an

overestimation of impact. However, given the consistency of the findings over the six competitions, it is more likely that the effects were associated with participation. Thirdly, there was no information retained on teams that did not make the minimum 20-registrant cut-off point at the start of each competition; these data have been collected since 2016. Finally, because KHC was a real-world competition and relied on non-research staff to collate data, baseline estimates of behaviours in some cases may have taken place once competition activities commenced, thereby possibly biasing impact estimates downwards. Further, self-report measures may also introduce biases towards more healthy behaviours; however, the primary outcome of weight was objectively measured at both pre- and post-intervention and showed patterns consistent with the other self-reported health behaviours.

### Conclusion

The KHC has shown to promote (at least) short-term reductions in weight and improvements in lifestyle-related risk factors promoting healthy lifestyles among Aboriginal communities in NSW. Addressing the key chronic disease risk factors, the KHC has potential to make an important contribution to closing the gap in health outcomes between Aboriginal and non-Indigenous people. Future research should explore characteristics of non-completers and qualitatively explore non-completion, reduced participation in the second competition in the year, and factors that hinder or encourage male participation in the KHC. Finally, future analyses should focus on repeating participants and their patterns of weight maintenance, regain or further loss between finishing and starting a new competition.

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### Data availability

The datasets generated and/or analysed during the current study are not publicly available due to the conditions of ethics approval. Data are available from the authors upon reasonable request and with permission of the NSW Ministry of Health.

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## Supporting Information

Additional supporting information may be found in the online version of this article:

**Supplementary Table 1:** Summary of data collection.

**Supplementary Table 2:** Adjusted beta coefficients ( $\beta$ ) and adjusted odds ratios (AOR) for comparisons of participant health characteristics at start of each competition across competitions 2012-2015.

**Supplementary Table 3:** Adjusted beta coefficients ( $\beta$ ) and adjusted odds ratios (AOR) for pre- post difference compared with reference competition.

**Supplementary Table 4:** Change in participant health characteristics from pre to post competition 2013-2015 among new participants within each competition.