

*Original Research Article***Physical Activity Levels in Alaska Native Children Participating in the Skiku/AK Nordic Program**Kiplin R. Taber<sup>1</sup>, Colin Campbell<sup>1</sup>, Melynda S. Coker<sup>1</sup>, Lars Flora<sup>2</sup>, Robert H. Coker<sup>1\*</sup><sup>1</sup> Institute of Arctic Biology; krtaber@alaska.edu, cecampbell2@alaska.edu, mscoker@alaska.edu, rcoker@alaska.edu<sup>2</sup> AK Nordic ; larsflora@yahoo.com

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**Abstract: Background:** Physical activity is recommended to mitigate the incidence of obesity, but delivery of community wide initiatives is cumbersome. The challenges met by such programs are magnified when implementation transpires in the remote villages of Alaska. To overcome the difficulty of this challenge in the Arctic, the Skiku/AK Nordic cross-country skiing program was developed. The objective of this study was to evaluate whether access to Skiku/AK Nordic program would promote physical activity levels that met the daily recommendations for physical activity in Alaska Native children. **Methods:** Eight children (4 females and 4 males; 10±2 years/age) were recruited from Kaktovik, Alaska for participation in this study. Expert coaches and staff provided one week of cross-country ski instruction and access to ski equipment. Physical activity was monitored using ActiGraph GT3X+ accelerometers. Data collected from the devices was then downloaded and analyzed using ActiLife software. **Results:** The participants expended ~586 calories/day devoted to physical activity. Light and moderate physical activity was 68±38 minutes/day and 447±248 minutes/day, respectively. **Conclusions:** Delivery of the Skiku/AK Nordic program promoted favorable levels of physical activity in Alaska Native children. Further research is needed to assess the longitudinal and seasonal effectiveness of the Skiku/AK Nordic program.

**Keywords:** Exercise, Health, Obesity, Northern Latitudes, Cross country skiing

**1. Introduction**

Childhood obesity is a public health crisis with no sign of abatement [1]. The trend towards overweight and obese school-aged children may be even more pronounced in Indigenous populations within the United States [2]. Self-report, pedometry, and accelerometry has shown that Native American children struggle to meet the recommendations for physical activity established by the World Health Organization [3]. Despite these circumstances, there are no data available on physical activity derived from wearable biometrics in Alaska Native children.

Effective programs are needed to augment physical activity and establish healthy dietary patterns so that the incidence of obesity can be minimized in all populations. Health benefits of physical activity can be short-term and long-term, contributing to reductions in high blood pressure, obesity, and/or depression [4]. Improvements in physical fitness and skeletal health, as well as the reduced incidence of chronic disease, have been directly connected to higher levels of physical activity or movement constancy [5,6]. Processed and commercialized foods, limited access to healthcare, lack of adequate resources and/or financial limitations can also play important detrimental roles. Taking these positives and negatives into consideration, it is also very clear that successful efforts must utilize community participation to fully empower the feasibility of any intervention

conducted in remote communities. In this way, interventions can be much more impactful, cohesive, and meaningful to the community [7].

The Skiku/AK Nordic program was developed in conjunction with support from communities, non-profit organizations and/or corporations to improve the overall health of children living in remote Alaska. The Skiku/AK Nordic program provided continual access to updated ski equipment and one week of expert-to-Olympic level instruction. Upon completion of this instructional phase, the community-level programs continued to provide the children with self-monitored and direct access to equipment at no cost. In conjunction with input from the Elders of Kaktovik, Alaska, the primary hypothesis was developed: the delivery of the Skiku/AK Nordic program would be consistent with favorable levels of physical activity that met or exceeded recommendations from the World Health Organization as measured by ActiGraph accelerometry [8].

## 2. Materials and Methods

Levels of physical activity were measured during an eight-day period of program instruction. All methods and procedures herein were approved by the University of Alaska Fairbanks Institutional Review Board and the Elders of Kaktovik, AK. We recruited 9 participants ( $10 \pm 2$  years of age; body weight of  $51 \pm 17$  kg; 4 females and 4 males) from the rural village of Kaktovik, Alaska (total population=262) to participate in this research study. Consent and assent were obtained in written form. At least one member of the research team was available to describe the study and answer any questions about the terminology and/or wording. Participants were also provided a copy of the consent/assent forms to discuss with their families.

We utilized the ActiGraph GT3X+ accelerometers (ActiGraph Corporation, Pensacola, FL) to assess physical activity [9]. These instruments have been shown to be valid for the measurement of physical activity in laboratory, epidemiological, and field studies [10]. Research staff demonstrated use and positioning of the devices on the dominant wrist. ActiGraph usage on the wrists of children is preferable in methodology and application because wear times tend to be longer for wrists as opposed to hips, leading to less user- and instrument-error and more fidelity in user compliance [11]. All children were encouraged to ask questions about the device. Each device was calibrated and validated through factory specifications before being specifically fitted and worn by each individual user. One participant was excluded from this sample due to instrument malfunction.

Once fitted to each individual prior to the start of the program, the ActiGraph GT3X+ accelerometers were worn throughout the week to provide continuous wireless monitoring of vertical, lateral, and front-to-back axis movements. We also utilized ActiLife software to interpret the data from the generated from the ActiGraphs, including metabolic equivalent algorithms. These measurements included energy expenditure, numbers of steps taken, and physical activity intensities (ie., light, moderate, and vigorous). Slightly adapted for beginners to cross-country skiing based on our previous work [12], our cut-point values were 1-149 (sedentary), 150-499 (light), 500 to 3999 (moderate), 4000 to 7599 (vigorous), and 7600 (very vigorous) physical activity [13]. The percentage of time spent in each stage, step counts, and steps per minute were also

calculated. The algorithms chosen were those that best match the characteristics of the research sample (i.e., generally accepted industry standard age ranges) [14].

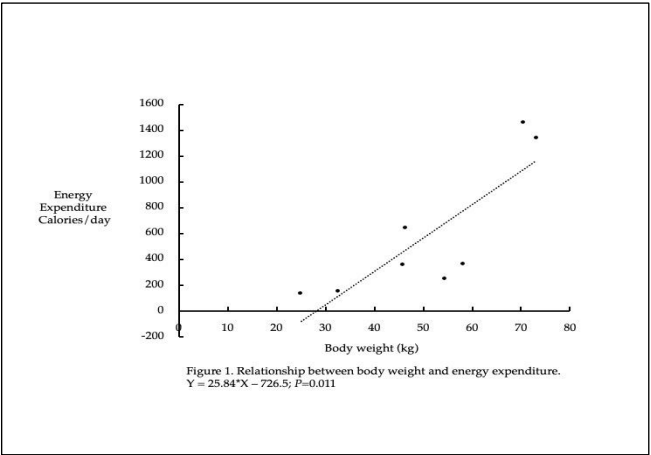
Statistical Analysis

We analyzed our data using a combination of ActiLife, Microsoft Excel, and Prism 9 software programs. All data includes eight total participants. Linear regression analysis was used to determine the relationship between body weight and caloric expenditure. Statistics were considered significant with a *P*-value of less than 0.05. Data are presented as means±SD.

3. Results

The total estimated activity-oriented energy expenditure was 3,634±3660 calories, 586±527/day, or 35±29 calories/hour. (Table 1). Participants spent a total of 4,684±2040 minutes in sedentary behavior, 341±189 minutes engaging in light physical activity, 2259±1252 minutes engaging in moderate physical activity, and zero minutes engaging in vigorous or very vigorous physical activity (Table 1).

Overall, 60±18% of time was spent engaging in sedentary behavior, 5±2% of time was spent engaging in light physical activity, and 35±17% of time was spent engaging in moderate physical activity (Table 1). There was a significant relationship between body weight and caloric expenditure (Figure 1).



This study was not specifically powered to investigate differences between males and females. Nevertheless, males tended to be heavier (62±12 kg) than females (40±13 kg) (*P*=0.06), and males shared a tendency to engage in higher levels of physical activity than females (Table 1). For example, males spent an average of 3,611±2395 minutes engaging in sedentary behavior, while females spent 5,757±953 minutes engaging in sedentary behavior. Males engaged in light physical activity for 354±233 minutes, while females engaged in 329±168 minutes of light physical activity. Finally, males spent 2,280±1549 minutes engaging in moderate physical activity and females spent 2,238±1122 minutes engaging in moderate physical activity (Table 1). In males, these activity levels translated to an energy expenditure of 950±532 calories/day and 59±19 calories/hour spent in sedentary, light, and moderate activities, whereas females reached a mean of 222±103 calories/day and 11±5 calories/hour. The percentage of time spent engaging in moderate physical activity was 45±16% for males and 26±9% for females (Table 1).

Table 1. ActiGraph derived data	Overall	Males	Females
Total calories	3,634±3,660	5,771±4,308	1,498±722
Calories/day	586±527	950±532	222±103
Calories/hour	35±29	59±19	11±5
Minutes Sedentary	4,684±2,040	3,611±2,395	5,757±953
Minutes Light Physical Activity	341±189	354±233	329±168
Minutes Moderate Physical Activity	2,259±1,252	2,280±1,549	2,238±1,122
Sedentary (% time engaged)	60±18	50±16	69±11
Light Physical Activity (% time engaged)	5±2	6±1	50±2
Moderate Physical Activity (% time engaged)	35±17	45±16	26±9
Steps/Day	11,338±4349	12,225±5325	10,451±4471
Steps/Minute	12±7	15±8	8±4
Steps Max Counts	26±4	22±2	30±1
Steps Average Counts	2.0±1.1	2.6±1.3	1.4±0.6
Vector Magnitude Max Counts	8,281±1,860	8,089±2,561	8,472±1,189
Vector Magnitude Average Counts	488±279	633±316	342±156
Axis 1 Average Counts	281±178	371±212	192±89
Axis 2 Average Counts	263±156	342±183	184±82
Axis 1 Max Counts	6,171±1,420	5,829±1,885	6,514±914
Axis 2 Max Counts	5,530±819	5,474±1,139	5,586±508
Axis 3 Max Counts	4354±903	4,047±1,150	4,662±573

#### 4. Discussion

Participation in the Skiku/AK Nordic ski program seemed to substantially influence physical activity in Alaska Native children living in Kaktovik, Alaska. Using wearable biometric devices (ie., Actigraph GT3X+ accelerometers), we were able to describe a robust level of physical activity in this cohort as compared to recommendations from the

U.S. Department of Health and Human Services and the World Health Organization, which advise at least one hour of moderate to vigorous physical activity per day [8]. The total amount of physical activity exceeded recommendations by over 5 hours/day but did not include any vigorous physical activity. During the instructional period while the coaches were physically present in Kaktovik, AK, students were exceptionally focused on the delivery of the program; learning the skills, and building engagement with and trust among others [15]. The encouraging structure of the ski program, easy access to equipment, social and community expectations for participation, and curiosity among the children were likely key factors in boosting these children's physical activity during this week. Such factors may be useful considerations for utilization in future community initiatives, particularly in remote areas. These results demonstrate considerable interest in outdoor physical activity among these Alaska Native children.

Normative data has demonstrated that children should average 12,000-16,000 steps per day [16]. Although the participants in this study generally met the recommended step count, it should be noted that the activity of skiing may influence these measurements by inflation (i.e., ski movements may not be equivalent to walking). This issue limits the interpretation of our data as algorithms specifically designed for cross-country skiing are simply unavailable [17]. Therefore, we acknowledge that energy expenditure derived from wearable biometrics may not precisely delineate energy expenditure in children, and especially under these circumstances [18,19]. We also recognize the small absolute number of participants in this study but also realize that our volunteers represented ~10% of the population in Kaktovik, AK who are 18 years old and younger. Therefore, the use of the ActiGraph-based data in this particular study allowed us to demonstrate levels of physical activity in Alaska Native children that are well above the recommendations, providing support for the potential long-term efficacy of the overall program.

This study reiterated what previous studies have found: male children tended to engage in higher levels of physical when compared to female children [20-22]. The root of these gender differences in physical activity beckons further research, but could be associated with individual, environmental, social, and developmental differences between genders [23]. Female children may also be more negatively affected by barriers to physical activity [24]. Social influence, weather, lack of motivation, and lack of energy can all present barriers to physical activity [25]. We did not evaluate how these impediments might manifest themselves in Indigenous peoples living in northern latitudes and these questions should be further examined in future studies by expanding the overall cohort of participants throughout the remote regions of Alaska.

Kaktovik, Alaska is located on the northern shore of Barter Island on the coast of the Beaufort Sea within the Arctic National Wildlife Refuge at 70.132832, -143.616230. Our study was conducted in May of 2018 during exceptionally good environmental conditions for cross-country skiing with mild temperatures (ie., -5°-0° C) and 19 hours of daylight. Given the potential negative influences of low light and even total darkness when combined with extreme cold during a long winter, it would be especially interesting to evaluate physical activity during various times of the year when low light conditions have been demonstrated to negatively affect physical activity in older adults [26].

## 5. Conclusions

The Alaska Native children who participated in this study demonstrated a high level of physical activity during the initial delivery of the Skiku/AK Nordic program. Compared to measurement of physical activity described in other studies and the recommended amount of physical activity for children, there is great potential for the success of this program through its combination of community support, expert instruction, and self-maintained and easily attainable equipment. The implementation of Skiku/AK Nordic program in Kaktovik, Alaska also demonstrates the likelihood that interest in physical activity throughout the community could potentially optimize overall levels of physical health. Future studies have now been planned to evaluate the longitudinal influence of the Skiku/AK Nordic program on chronic levels of physical activity in Alaska Native youth living in this remote Arctic region of the United States.

**Author contributions:** Conceptualization, L.F. and R.H.C.; methodology, C.C., L.F. and R.H.C.; formal analysis, K.T., M.S.C. and R.H.C.; investigation, K.T., C.C., and R.H.C.; data curation, K.T., C.C., and R.H.C.; writing-original draft preparation, K.T., C.C., and R.H.C.; writing-review and editing, K.T., M.S.C., and R.H.C.; project administration, L.F., and R.H.C.; funding acquisition, L.F., and R.H.C. All authors have read and agreed to the published version of the manuscript.

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**Institutional Review Board Statement:** This study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the University of Alaska Institutional Review Board (Protocol 584562-8).

**Informed Consent Statement:** Informed consent and assent was obtained from all subjects involved in the study

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author. The data are not publicly available due to the fact that the participants were children from an underrepresented group of the population.

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**Conflicts of Interest:** None to declare.



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