



Outdoor activities and sunburn among urban and rural families in a Western region of the US: Implications for skin cancer prevention

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ABSTRACT

Prevention of skin cancer involves decreasing exposure to ultraviolet radiation (UVR) and avoiding sunburn, especially early in life. Individuals living in urban versus rural areas, as defined by the Rural Urban Commuting Area (RUCA) code classification, have different risks for skin cancer, likely due to differing patterns of outdoor activities and preventive behaviors employed when outdoors. However, few studies have examined differences in outdoor activities between rural and urban individuals and examined this among both adults and children. This study compared the outdoor activities, sun protection strategies, tanning behaviors, and sunburn occurrence of adults and children (n = 97 dyads) in rural versus urban settings in a Western region of the United States. The relationships between outdoor activities and sunburn occurrence were examined in both groups. Analyses employed Barnard's Exact Test and logistic generalized estimating equations models. Individuals in rural and urban areas reported differences in sun protection strategies used, tanning behaviors, and outdoor activities. Individuals in urban areas more commonly reported use of certain forms of sun protection, such as sunscreen and shade, whereas long pants and skirt wearing were more common for children in rural areas. Individuals in rural areas were more likely than those in urban areas to engage in farm work, yard work, and youth sports. Gender differences in these outcomes were also identified. Skin cancer preventive interventions could be tailored for rural and urban families to target sun protection strategies to outdoor activities and to situations in which sunburns are likely to occur.

Skin cancer is the most commonly diagnosed cancer, affecting more than 5 million people in the U.S. annually (Fitzmaurice et al., 2019; Guy et al., 2015). Melanoma is the most lethal form of skin cancer, with long-term survival rates of < 10 % following development of distant metastases (Surveillance Epidemiology and End Results Program, 2020). Individuals can lower their risk for developing skin cancer by decreasing ultraviolet radiation (UVR) exposure and sunburn, especially during childhood (Armstrong and Cust, 2017; Balk, 2011; Green et al., 2011; PDQ Screening and Prevention Editorial Board, 2017; US Department of Health and Human Services, 2014; Wu et al., 2014). Recommended

strategies to decrease UVR exposure include wearing protective clothing, seeking shade when outdoors, applying and re-applying sunscreen to exposed skin, and avoidance of tanning through artificial sources or in outdoor settings. Unfortunately, use of sun protection is suboptimal in both adults and children, and subsequently 20–33 % of adults and up to 83 % of children experience one or more sunburns during the summer or yearly (Buller et al., 2011; Geller et al., 2002; National Cancer Institute, 2020).

Geographic disparities exist for both the incidence of melanoma and use of recommended skin cancer prevention strategies. Individuals in

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rural areas have a higher incidence of and mortality from melanoma than individuals in urban communities across the United States (Blake et al., 2017), which may be due to increased UVR exposure (occupational or other) and lower use of recommended sun protection strategies compared to those who live in urban areas (Bodekaer et al., 2015; Cunningham et al., 2019; Kalia et al., 2013). (Bodekaer et al., 2014) There is evidence that rural and urban residents differ in their use of sun protection methods. For example, among adults, rural residents report more time spent outdoors on both weekdays and weekends, are more likely to report suboptimal sunscreen use, and are more likely to wear protective clothing and seek shade compared to urban residents (Jewett et al., 2020; Vogel et al., 2021; Zahnd et al., 2010). Children in rural areas use some forms of sun protection (e.g., sunscreen, long-sleeved shirts, shade-seeking) less frequently than their urban counterparts, but are more likely to wear long pants or skirts and hats (Fritschi et al., 1992; Nagelhout et al., 2019). Together, the increased UVR exposure from outdoor activities and inconsistent use of sun protection could help to explain increased sunburn occurrence, and hence increased skin cancer risk, among rural residents compared to urban residents (Cunningham et al., 2019).

What remains unknown are the types of outdoor activities in which urban and rural adults and children engage, and the relationships between types of outdoor activities and occurrence of sunburn, the primary modifiable risk factor for melanoma. A better understanding of the outdoor activities that adults and children engage in and sunburn risk associated with those activities, in both rural and urban areas, will help to inform the development of skin cancer preventive interventions that are better tailored to the behavior patterns and preferences of individuals in those regions. The goal of the current study was to compare reported frequency of participation in different types of outdoor activities, sunburn occurrence, sun protection strategies used, and tanning behaviors among parents and children in rural and urban settings. In addition, this study examined the relationships between outdoor activity type and sunburn occurrence among rural and urban adults and children.

1. Methods

1.1. Participants

Parents and children from 97 families with at least one parent and one child between the ages of 8 and 17 years from each family participated in a two week study. Data were collected between June and October 2018. Parents were eligible to participate if they were at least 18 years of age, were the primary caregiver to at least one child residing in the same household aged 8–17 years, lived in the state of Utah, had access to a smartphone, did not have a pacemaker which could interfere with the UVR monitoring device and were willing to use a smartphone app that shared their and their child’s UVR exposure information with the research team. In order to participate, children had to be between the ages of 8 and 17 years of age, live in Utah, not have a personal history of skin cancer, not have a pacemaker, and not be taking sun sensitizing medication. We chose 8 as the minimum age to ensure that children could complete self-report measures. Potential participants were recruited from flyers distributed in medical facilities and community settings (e.g., grocery stores, schools, and gas stations), community health promotion fairs and other events and directed mailings to individuals living in the state of Utah. Most enrolled participants were recruited through a community health fair (n = 64) and direct mailers (n = 60). Other successful recruitment methods included: flyers (n = 22), word of mouth (n = 12), advertisements on the university website (n = 17) and other/unspecified sources (n = 49). A total of 224 adults contacted the research team regarding participation in the study, and of these 150 were screened, 116 were eligible, and 97 participated. The primary reason for ineligibility was not having a child in the desired age range.

Table 1
Demographic characteristics of study participants.

	Total Sample (n = 97)	Urban (n = 56)	Rural (n = 41)	p-value**
Adults	n (%)*	n (%)*	n (%)*	
Age (M, IQR)	40.00 (37.00, 45.00)	42.00 (37.00, 45.00)	40.00 (38.00, 44.50)	0.67
Sex				
Male	22 (23.1)	9 (16.1)	13 (33.3)	0.052
Female	73 (76.8)	47 (83.9)	26 (66.7)	
Marital status				
Married or marriage-like relationship	84 (88.4)	53 (94.6)	31 (75.6)	0.027
Divorced or Separated	9 (9.5)	2 (3.6)	7 (17.1)	
Widowed	2 (2.1)	1 (1.8)	1 (2.6)	
Level of education				
High school graduate or GED	8 (8.4)	0 (0)	8 (20.5)	<0.001
Vocational or technical school	8 (8.4)	2 (3.6)	6 (15.4)	
Some college, including 2 yr. degree	33 (34.7)	18 (32.1)	15 (38.5)	
Bachelor’s Degree	25 (26.3)	18 (32.1)	7 (17.9)	
Master’s Degree or	21 (22.1)	18 (32.1)	3 (7.7)	
Doctoral Degree				
Race/Ethnicity				
Non-Hispanic White	83 (87.4)	46 (82.1)	37 (94.9)	0.07
Hispanic	5 (5.3)	4 (7.1)	1 (2.6)	
Asian or Asian American	5 (5.3)	5 (8.9)	0 (0)	
Other	2 (2.1)	1 (1.8)	1 (2.6)	
Family income				
<\$60,000	30 (31.6)	13 (23.2)	17 (43.6)	0.06
≥\$60,000	57 (60.0)	38 (67.9)	19 (48.7)	
I would rather not report this	8 (8.4)	5 (8.9)	3 (7.7)	
Occupation				
Environment				
Mainly indoors	82 (86.3)	53 (95.6)	29 (74.4)	0.007
Mainly outdoors	9 (9.5)	1 (1.8)	8 (20.5)	
In a motor vehicle	3 (3.2)	1 (1.8)	2 (5.1)	
Elsewhere	1 (1.1)	1 (1.8)	0 (0)	
Children (n = 97)	(n = 56)	(n = 41)		
Age (M, IQR)	13.00 (10.50, 15.00)	12.00 (9.75, 14.00)	13.00 (13.00, 16.00)	0.002
Sex				
Male	39 (41.1)	24 (42.9)	15 (38.5)	0.67
Female	56 (58.9)	32 (57.1)	24 (61.5)	
Race/Ethnicity				
Non-Hispanic White	81 (85.3)	44 (78.6)	37 (94.9)	0.032
Hispanic	8 (8.4)	7 (12.5)	1 (2.6)	
Asian or Asian American	4 (4.2)	4 (7.1)	0 (0)	
Other	2 (2.1)	1 (1.8)	1 (2.6)	

*n and % reported for demographic variables unless otherwise noted.

**Exact Wilcoxon rank sum test for continuous demographic characteristics and Wilcoxon rank sum test for categorical characteristics.

1.2. Measures

1.2.1. Demographic characteristics

Parents were asked to report on demographic characteristics for themselves and their participating child (see Table 1). Each dyad’s home zip code was categorized as rural or urban using the Rural Urban Commuting Area (RUCA) code classification (WWAMI Rural Health Research Center, 2017).

1.2.2. Sun protection behaviors, tanning, and sunburn occurrence

At a baseline assessment, participants were asked about their sun

protection behaviors such as sunscreen use, protective clothing use, shade seeking, and avoidance of peak UVR hours of the day, tanning behaviors such as indoor tanning, intentional outdoor tanning, and unintentional outdoor tanning (ending up with a tan when one was not intending to tan), and sunburn occurrence over the past month. These 5 point Likert-type items were based on the Sun Habits Survey (Glanz et al., 2008). Participants were also asked to report on sunburn occurrence (Yes/No) on a daily basis for the 2-week study period. Parents were asked to report on themselves and on their children and children were asked to report on themselves.

1.2.3. Outdoor activities

Each day of the 2-week study period, participants were asked to report on their outdoor activities for that day. Parents were asked to report on their own activities and their child's activities and children were asked to report on their own activities. A research assistant coded each activity into an activity type category such as exercise, farm work, or water activities. The activity type categories were created based on open coding of all activities reported. A second research assistant completed reliability coding of 20 % of all reported activities with 98 % agreement.

1.3. Procedures

Parent-child dyads provided informed consent/assent and were enrolled between the months of June and October. Participants were asked to complete a baseline questionnaire and daily questionnaires about their outdoor activities and sunburn occurrence. All surveys were completed electronically via REDCap (Harris et al., 2009). Both parent and child participants received gift cards for their study participation. All study procedures met the guidelines for protection of safety and privacy of human subjects and were approved by the relevant Institutional Review Board.

1.4. Statistical analyses

Questionnaire responses were summarized as the median and interquartile range for quantitative variables and count and percentage for categorical variables. All statistical analyses were conducted using R. The exact Wilcoxon rank-sum test was conducted for quantitative variables and ordinal variables to examine potential differences between rural and urban individuals and by sex for demographic characteristics, baseline sun protection behaviors, and outdoor activities over the two-week study period. The Barnard's Exact Test for independence was used to compare the rate of sunburns based on the daily sunburn data (proportion of days with sunburn given the number of days participants reported that outdoor activity) for particular activity exposures across rural parents versus urban parents and similarly for children (Barnard, 1947). The same analyses were repeated to compare the rate of sunburns based on the daily sunburn data across female versus male parents, female rural parents versus female urban parents, and male rural parents versus male urban parents. Analyses were also conducted with study enrollment season (summer vs fall) controlled for, and the pattern of results was consistent. Logistic Generalized Estimating Equation (GEE) models were used to estimate the association between daily peak UVR exposure and daily sunburn clustered by person, adjusting for Fitzpatrick skin type and location (rural vs urban) (Zeger et al., 1988). An exchangeable correlation structure was used, assuming observations within subjects are equally correlated. For children, we fit a similar model to assess the relationship between daily UV exposure and sunburns.

2. Results

In total, 97 parent-child dyads participated, with 56 dyads (58 %) residing in urban locations and the remainder 41 dyads (42 %) in rural

Table 2a
Parent sun protection, tanning and sunburn occurrence at baseline.

	Urban 56 (58 %)	Rural 41 (42 %)	p-value*
	N = 56	N = 41	
Sunscreen application			
Never	6 (10.7 %)	18 (46.2 %)	<0.001
Rarely	13 (23.2 %)	6 (15.4 %)	–
Sometimes	16 (28.6 %)	8 (20.5 %)	–
Often	10 (17.9 %)	5 (12.8 %)	–
Always	11 (19.6 %)	2 (5.1 %)	–
Sunscreen re-application			
Never	19 (33.9 %)	23 (59 %)	0.06
Rarely	20 (35.7 %)	6 (15.4 %)	–
Sometimes	6 (10.7 %)	4 (10.3 %)	–
Often	9 (16.1 %)	6 (15.4 %)	–
Always	2 (3.6 %)	0 (0 %)	–
Long-sleeved shirt			
Never	21 (37.5 %)	16 (41 %)	0.53
Rarely	16 (28.6 %)	13 (33.3 %)	–
Sometimes	11 (19.6 %)	6 (15.4 %)	–
Often	8 (14.3 %)	3 (7.7 %)	–
Always	0 (0 %)	1 (2.6 %)	–
Long pants or skirt			
Never	9 (16.1 %)	4 (10.3 %)	0.30
Rarely	10 (17.9 %)	9 (23.1 %)	–
Sometimes	18 (32.1 %)	8 (20.5 %)	–
Often	14 (25 %)	11 (28.2 %)	–
Always	5 (8.9 %)	7 (17.9 %)	–
Hat			
Never	23 (41.1 %)	24 (61.5 %)	0.34
Rarely	12 (21.4 %)	3 (7.7 %)	–
Sometimes	15 (26.8 %)	3 (7.7 %)	–
Often	5 (8.9 %)	5 (12.8 %)	–
Always	1 (1.8 %)	4 (10.3 %)	–
Shade			
Never	3 (5.4 %)	5 (12.8 %)	0.003
Rarely	10 (17.9 %)	15 (38.5 %)	–
Sometimes	25 (44.6 %)	14 (35.9 %)	–
Often	18 (32.1 %)	5 (12.8 %)	–
Always	0 (0 %)	0 (0 %)	–
Avoiding 10 am-4 pm exposure			
Never	7 (12.5 %)	8 (20.5 %)	0.07
Rarely	11 (19.6 %)	10 (25.6 %)	–
Sometimes	23 (41.1 %)	16 (41 %)	–
Often	14 (25 %)	5 (12.8 %)	–
Always	1 (1.8 %)	0 (0 %)	–
Sunglasses			
Never	5 (8.9 %)	6 (15.4 %)	0.19
Rarely	4 (7.1 %)	4 (10.3 %)	–
Sometimes	6 (10.7 %)	6 (15.4 %)	–
Often	21 (37.5 %)	12 (30.8 %)	–
Always	20 (35.7 %)	11 (28.2 %)	–
Outdoor intentional tanning			
Never	39 (69.6 %)	34 (87.2 %)	0.08
Rarely	15 (26.8 %)	2 (5.1 %)	–
Sometimes	1 (1.8 %)	3 (7.7 %)	–
Often	1 (1.8 %)	0 (0 %)	–
Always	0 (0 %)	0 (0 %)	–
Outdoor unintentional tanning			
Never	6 (10.7 %)	2 (5.1 %)	0.045
Rarely	7 (12.5 %)	4 (10.3 %)	–
Sometimes	29 (51.8 %)	13 (33.3 %)	–
Often	8 (14.3 %)	17 (43.6 %)	–
Always	6 (10.7 %)	3 (7.7 %)	–
Number of sunburns			
0	42 (75 %)	25 (64.1 %)	0.26
1	12 (21.4 %)	12 (30.8 %)	–
2	1 (1.8 %)	2 (5.1 %)	–
3	1 (1.8 %)	0 (0 %)	–
4+	0 (0 %)	0 (0 %)	–

*Wilcoxon rank sum test.

locations. Across the entire sample, parents (77 % female) were on average 41.6 years old (SD 6.3 years) and children (59 % female) were 12.7 years old (SD 2.7 years). Urban parents reported a significantly higher level of education than rural parents. A higher proportion of rural parents reported having an occupation that was primarily outdoors

Table 2b
Child sun protection, tanning, and sunburn occurrence at baseline.

	Child self-report			Parent-report on child		
	Urban 56 (58 %)	Rural 41 (42 %)	p- value*	Urban 56 (58 %)	Rural 41 (42 %)	p- value*
	N = 58	N = 41		N = 58	N = 41	
Sunscreen application						
Never	9 (16.7 %)	13 (32.5 %)	0.011	11 (19.6 %)	13 (33.3 %)	0.032
Rarely	11 (20.4 %)	9 (22.5 %)	-	8 (14.3 %)	8 (20.5 %)	-
Sometimes	14 (25.9 %)	12 (30 %)	-	17 (30.4 %)	10 (25.6 %)	-
Often	13 (24.1 %)	6 (15 %)	-	10 (17.9 %)	6 (15.4 %)	-
Always	7 (13 %)	0 (0%)	-	10 (17.9 %)	2 (5.1 %)	-
Sunscreen re-application						
Never	13 (24.1 %)	15 (37.5 %)	0.08	16 (29.6 %)	15 (38.5 %)	0.08
Rarely	15 (27.8 %)	12 (30 %)	-	12 (22.2 %)	13 (33.3 %)	-
Sometimes	16 (29.6 %)	9 (22.5 %)	-	14 (25.9 %)	7 (17.9 %)	-
Often	8 (14.8 %)	4 (10 %)	-	7 (13 %)	3 (7.7 %)	-
Always	2 (3.7 %)	0 (0%)	-	5 (9.3 %)	1 (2.6 %)	-
Long-sleeved shirt						
Never	21 (38.9 %)	16 (40 %)	0.56	17 (30.4 %)	16 (41 %)	0.34
Rarely	20 (37 %)	18 (45 %)	-	23 (41.1 %)	13 (33.3 %)	-
Sometimes	8 (14.8 %)	4 (10 %)	-	12 (21.4 %)	9 (23.1 %)	-
Often	5 (9.3 %)	2 (5%)	-	1 (1.8 %)	1 (2.6 %)	-
Always	0 (0%)	0 (0%)	-	3 (5.4 %)	0 (0%)	-
Long pants or skirt						
Never	11 (20.4 %)	3 (7.5 %)	0.042	10 (17.9 %)	5 (12.8 %)	0.28
Rarely	11 (20.4 %)	7 (17.5 %)	-	20 (35.7 %)	12 (30.8 %)	-
Sometimes	16 (29.6 %)	12 (30 %)	-	16 (28.6 %)	13 (33.3 %)	-
Often	16 (29.6 %)	16 (40 %)	-	8 (14.3 %)	5 (12.8 %)	-
Always	0 (0%)	2 (5%)	-	2 (3.6 %)	4 (10.3 %)	-
Hat						
Never	41 (75.9 %)	28 (70 %)	0.46	40 (72.7 %)	25 (65.8 %)	0.47
Rarely	5 (9.3 %)	4 (10 %)	-	11 (20 %)	9 (23.7 %)	-
Sometimes	6 (11.1 %)	4 (10 %)	-	3 (5.5 %)	-	-

Table 2b (continued)

	Child self-report			Parent-report on child		
	Urban 56 (58 %)	Rural 41 (42 %)	p- value*	Urban 56 (58 %)	Rural 41 (42 %)	p- value*
Often	2 (3.7 %)	4 (10 %)	-	1 (1.8 %)	4 (10.5 %)	-
Always Shade	0 (0%)	0 (0%)	-	0 (0%)	0 (0%)	-
Never	4 (7.4 %)	6 (15 %)	0.34	10 (18.2 %)	6 (15.4 %)	1.00
Rarely	17 (31.5 %)	12 (30 %)	-	20 (36.4 %)	14 (35.9 %)	-
Sometimes	20 (37 %)	15 (37.5 %)	-	18 (32.7 %)	17 (43.6 %)	-
Often	13 (24.1 %)	7 (17.5 %)	-	4 (7.3 %)	2 (5.1 %)	-
Always	0 (0%)	0 (0%)	-	3 (5.5 %)	0 (0%)	-
Avoiding 10 am-4 pm exposure						
Never	9 (16.7 %)	13 (32.5 %)	0.20	9 (16.4 %)	11 (29.7 %)	0.26
Rarely	23 (42.6 %)	12 (30 %)	-	21 (38.2 %)	11 (29.7 %)	-
Sometimes	15 (27.8 %)	13 (32.5 %)	-	17 (30.9 %)	11 (29.7 %)	-
Often	7 (13 %)	2 (5%)	-	3 (5.5 %)	4 (10.8 %)	-
Always	0 (0%)	0 (0%)	-	5 (9.1 %)	0 (0%)	-
Sunglasses						
Never	20 (37 %)	18 (45 %)	0.95	24 (42.9 %)	15 (39.5 %)	0.53
Rarely	20 (37 %)	9 (22.5 %)	-	19 (33.9 %)	10 (26.3 %)	-
Sometimes	7 (13 %)	6 (15 %)	-	6 (10.7 %)	8 (21.1 %)	-
Often	6 (11.1 %)	4 (10 %)	-	3 (5.4 %)	3 (7.9 %)	-
Always	1 (1.9 %)	3 (7.5 %)	-	4 (7.1 %)	2 (5.3 %)	-
Outdoor intentional tanning						
Never	45 (83.3 %)	31 (77.5 %)	0.66	49 (87.5 %)	34 (87.2 %)	0.89
Rarely	2 (3.7 %)	7 (17.5 %)	-	6 (10.7 %)	2 (5.1 %)	-
Sometimes	6 (11.1 %)	2 (5%)	-	1 (1.8 %)	3 (7.7 %)	-
Often	1 (1.9 %)	0 (0%)	-	0 (0%)	0 (0%)	-
Always	0 (0%)	0 (0%)	-	0 (0%)	0 (0%)	-
Outdoor unintentional tanning						
Never	6 (11.1 %)	3 (7.5 %)	0.07	6 (10.7 %)	5 (13.2 %)	0.51
Rarely	11 (20.4 %)	3 (7.5 %)	-	7 (12.5 %)	3 (7.9 %)	-
Sometimes	16 (29.6 %)	12 (30 %)	-	23 (41.1 %)	13 (34.2 %)	-

(continued on next page)

Table 2b (continued)

	Child self-report			Parent-report on child		
	Urban 56 (58 %)	Rural 41 (42 %)	p- value*	Urban 56 (58 %)	Rural 41 (42 %)	p- value*
Often	18 (33.3 %)	18 (45 %)	–	12 (21.4 %)	10 (26.3 %)	–
Always	3 (5.6 %)	4 (10 %)	–	8 (14.3 %)	7 (18.4 %)	–
Number of sunburns						
0	40 (74.1 %)	25 (62.5 %)	0.18	42 (75 %)	31 (79.5 %)	0.68
1	10 (18.5 %)	8 (20 %)	–	11 (19.6 %)	5 (12.8 %)	–
2	3 (5.6 %)	6 (15 %)	–	2 (3.6 %)	2 (5.1 %)	–
3	0 (0 %)	1 (2.5 %)	–	1 (1.8 %)	1 (2.6 %)	–
4	1 (1.9 %)	0 (0 %)	–	0 (0 %)	0 (0 %)	–
5 or more	0 (0 %)	0 (0 %)	–	0 (0 %)	0 (0 %)	–

*Wilcoxon rank sum test.

compared to urban parents. Demographic characteristics are summarized in Table 1.

2.1. Sun protection behaviors, tanning, and sunburn occurrence at baseline

Sunscreen and outdoor shade use were higher among urban parents than rural parents ($p < 0.001$, $p = 0.003$, respectively). Sunscreen use based on child-report was significantly lower among rural children than urban children ($p = 0.011$). Children in rural areas reported significantly higher use of long pants/skirt than children in urban areas ($p = 0.042$). Results suggested that sunscreen re-application may be higher among urban parents and children than their rural counterparts ($p = 0.06$, 0.08 , respectively); however, these differences were not statistically significant. Unintentional tanning was higher among rural parents than urban parents ($p = 0.045$), with suggestive evidence of being higher among rural children than urban children ($p = 0.07$). Avoidance of peak UVR hours may be more common among urban adults than rural adults ($p = 0.07$). In contrast, outdoor intentional tanning may be more common among urban adults than rural adults ($p = 0.08$). No adult or child participants endorsed indoor tanning. There were no other statistically significant differences between rural and urban parents or children on other sun protection or tanning behaviors (Table 2).

There was evidence across the entire sample for gender differences in sun protection outcomes and sunburn occurrence, but not for tanning. For parents, women reported higher sunscreen use than men ($p = 0.008$). Men reported a significantly higher frequency of wearing long pants than women ($p < 0.001$). Parents reported that their daughters reapplied sunscreen, wore long sleeves, and tanned intentionally outdoors more frequently than sons ($p = 0.017$, $p = 0.034$, and $p = 0.014$, respectively). Girls reported wearing long pants more frequently than

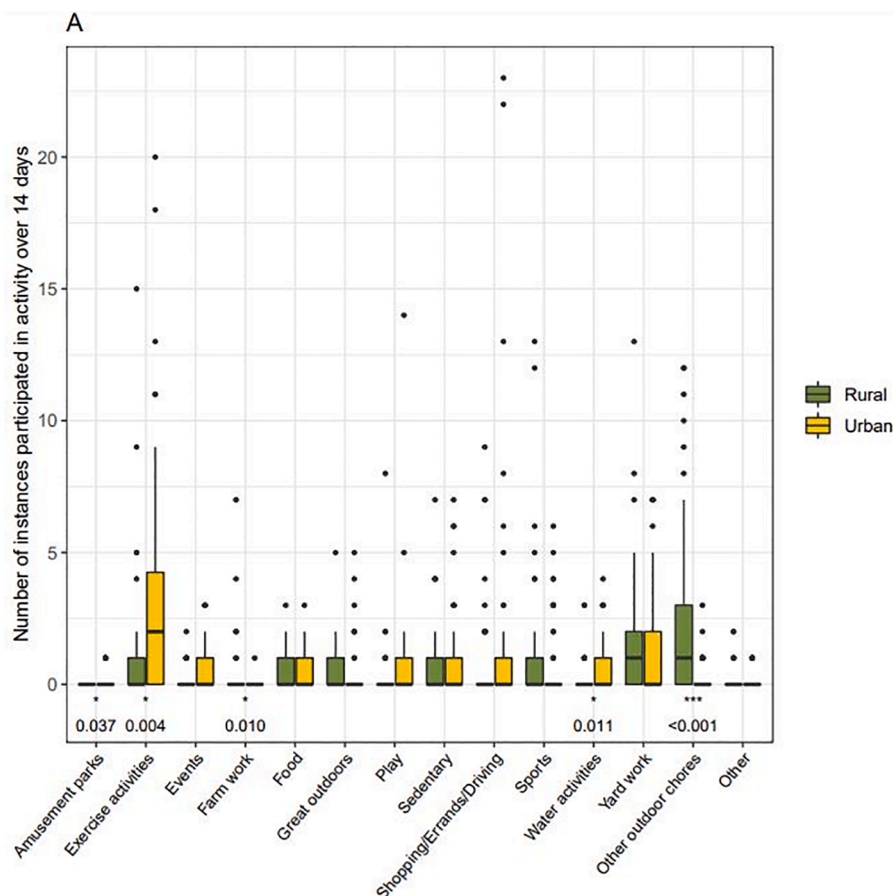


Fig. 1a. *: Frequency of participation in outdoor activities over two weeks (Parent self report).

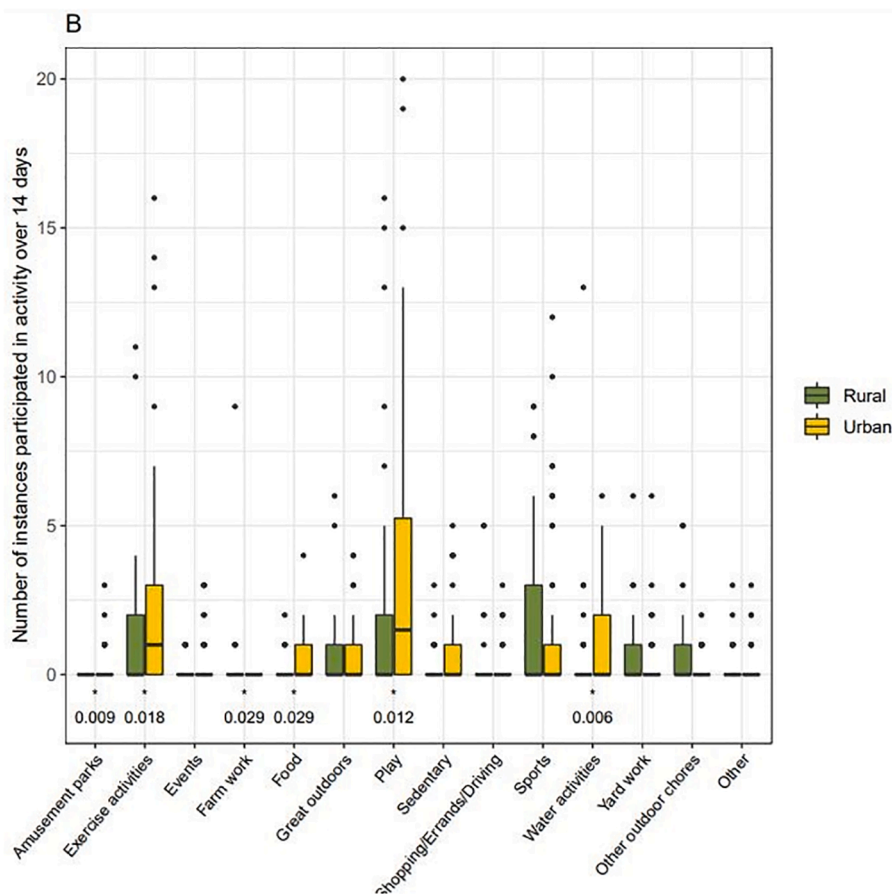


Fig. 1b. *: Frequency of participation in outdoor activities over two weeks (Child self-report).

boys ($p = 0.01$) while boys reported wearing hats more frequently than girls ($p = 0.032$).

Next, potential differences in outcomes between rural and urban individuals were examined, within gender. For mothers, those in urban areas reported more frequent use of sunscreen ($p = 0.003$) and shade-seeking ($p = 0.017$) compared to mothers in rural areas, while mothers in rural areas reported more frequent unintentional tanning ($p = 0.016$) than mothers in urban areas. There were no significant differences in sun protection and tanning outcomes between fathers in rural versus urban settings. For their children, parents and children in urban areas reported more frequent use of sunscreen ($p < 0.001$, $p = 0.006$, respectively) and sunscreen re-application (parent-report: $p = 0.007$) compared to girls in rural areas. Parents of boys in urban settings reported more frequent shade use ($p = 0.004$) and avoidance of peak hours ($p = 0.033$) than those in rural settings. Boys in rural settings reported wearing long pants more frequently than boys in urban settings ($p = 0.006$). Parents of boys in rural settings reported more frequent unintentional outdoor tanning than parents of boys in urban settings ($p = 0.007$).

2.2. Outdoor activities

Urban and rural participants had different levels of reported engagement in certain types of outdoor activities (Figs. 1a-c). Urban parents reported the following outdoor activities for themselves and/or their children more than rural parents: going to amusement parks ($p = 0.03$ and $p = 0.007$, respectively), exercising ($p = 0.003$ parents only), water activities ($p = 0.01$ and $p = 0.001$, respectively), and play ($p = 0.04$ children only). In contrast, rural parents reported the following outdoor activities for themselves and/or their children more than urban parents: farm work ($p = 0.027$ and $p = 0.017$, respectively), sports ($p =$

0.007 children only), yard work ($p = 0.01$ children only), and other outdoor chores (both $p < 0.001$). Children self-reported a similar pattern of findings (see Table 3).

There were some gender differences in reported activities. Across the entire sample, women reported engaging in exercise activities more often than men ($p = 0.003$) while men reported completing outdoor chores more frequently than women ($p = 0.002$). For parent report on children, there were no statistically significant differences in reported activities by child gender. Boys reported participating in sports more often than girls ($p = 0.028$).

Next, potential differences in reported activities between rural and urban individuals was examined, within gender. Women in rural areas reported that their outdoor activities included farm work ($p = 0.032$) and outdoor chores ($p = 0.002$) more frequently than women in urban areas. There were no statistically significant differences in outdoor activity frequencies for men. For girls, parents reported more frequent amusement park visits ($p = 0.032$), exercise activities ($p = 0.005$), events such as concerts and parades ($p = 0.033$), and water activities ($p = 0.003$) for girls in urban settings, whereas outdoor chores were more frequently reported for girls in rural settings ($p = 0.015$). Girls in urban settings similarly reported more frequent amusement park visits ($p = 0.029$) and water activities ($p = 0.013$) than girls in rural settings. For boys, parents reported more frequent outdoor chores for boys in rural settings compared to boys in urban settings ($p < 0.001$). Boys in urban settings reported more outdoor play than boys in rural settings ($p = 0.027$).

2.3. Risk for sunburn based on type of outdoor activity

Across all the days rural and urban parents played sports, the rate of sunburns was greater among rural parents than among urban parents

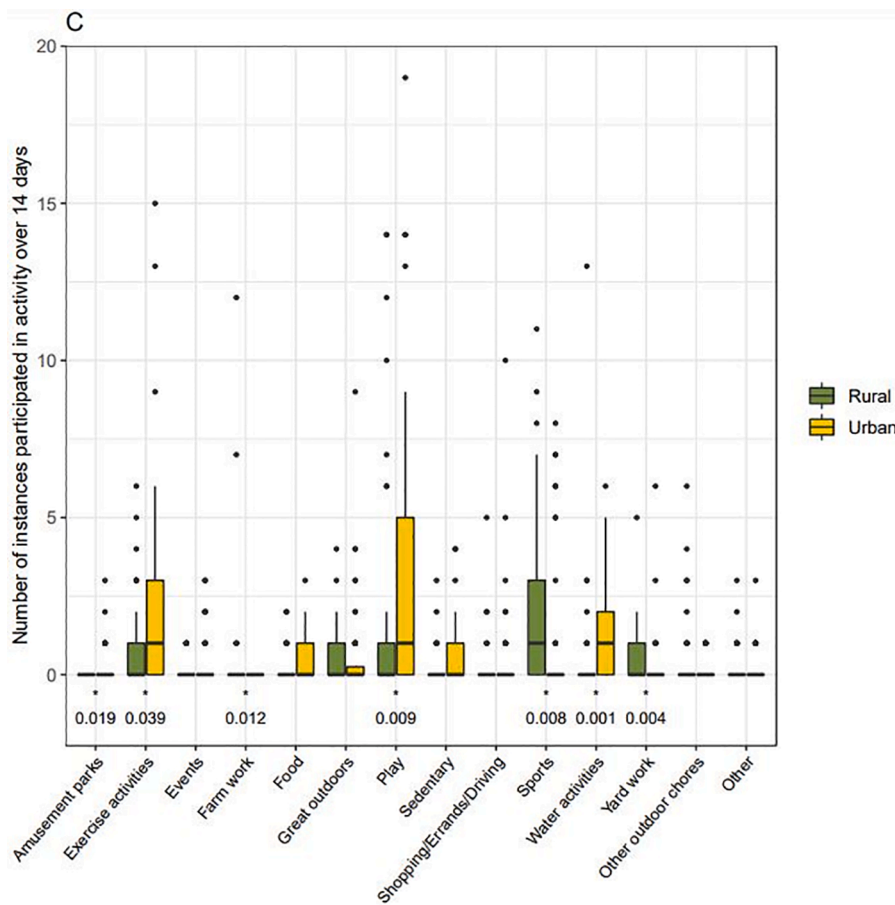


Fig. 1c. *. Frequency of participation in outdoor activities over two weeks (Parent-report on children). *The x-axis describes the type of activities, and the y-axis represents the frequency of participation in each activity over 14 days. Urban participants are represented in yellow and rural participants are represented in green. P-values (noted above the type of activities on the x-axis) compare frequency of participation in each activity in rural vs urban areas over 14 days. * for p-value < 0.05, and ** for p-value < 0.001.

Table 3
Cumulative days spent by outdoor activity types in rural and urban participants.

Activity type	Parent self-report			Parent-report on child			Child self-report		
	Urban 56 (58 %)	Rural 41 (42 %)	<i>p</i> *	Urban 56 (58 %)	Rural 41 (42 %)	<i>p</i> *	Urban 56 (58 %)	Rural 41 (42 %)	<i>p</i> *
Amusement park	6	0	0.037	11	0	0.019	12	0	0.009
Exercise	184	55	0.004	115	38	0.039	139	56	0.018
Events (e.g., parade)	26	7	0.06	19	5	0.26	19	5	0.28
Farm work	1	17	0.010	0	22	0.012	0	12	0.029
Food	29	14	0.23	21	10	0.31	23	5	0.029
Great outdoors	20	19	0.08	34	25	0.47	29	28	0.66
Play	39	16	0.12	184	82	0.009	200	84	0.012
Sedentary	55	28	0.14	27	10	0.18	35	10	0.08
Shopping/Errands/ Driving	97	40	0.44	28	12	0.52	13	15	0.98
Sports	38	59	0.08	57	86	0.008	81	80	0.23
Water activities	39	11	0.011	64	25	0.001	66	26	0.006
Yard work	78	66	0.59	15	27	0.004	22	27	0.052
Other outdoor chores	16	102	<0.001	8	23	0.13	13	25	0.33
Other	6	8	0.48	11	11	0.68	12	12	0.39

* Exact Wilcoxon rank sum test.

(rate rural = 7/59 and urban = 0/38; *p* = 0.028). Though not statistically significant, the number of sunburns on days they attended events such as concerts and parades was lower among rural parents than urban parents (rate rural = 1/7 and urban = 0/26; *p* = 0.098). No significant differences were seen in sunburn occurrence (both parent-and child self-reported) between rural and urban children across activity types.

Across the entire sample, men were more likely to report receiving a sunburn when doing yard work (*p* = 0.043) than women. There was a trend such that women were more likely to report sunburn when playing

sports (*p* = 0.088) than men. Parents reported that boys were more likely than girls to experience a sunburn on days they did exercise activities (*p* = 0.031). There was a trend such that girls reported more sunburn on days they engaged in outdoors activities such as camping, hiking, and hunting (*p* = 0.089). There was a trend such that boys reported a greater likelihood of sunburn on days they engaged in water activities (*p* = 0.058).

Next, potential differences in outcomes between rural and urban individuals were examined, within gender. There were not statistically

significant differences between rural or urban men or women. Parents in urban areas reported that daughters were more likely to experience a sunburn during water activities ($p = 0.027$) than parents in rural areas. Girls in rural settings were more likely to report experiencing sunburn during farm work than girls in urban settings ($p = 0.035$).

3. Discussion

To our knowledge, this is one of the first studies to document both the outdoor activities and the relationship between these activities and sunburn occurrence for both rural and urban parents and children. The results indicate that individuals living in rural and urban settings report different patterns of sun protection behaviors and different outdoor activities. Individuals in rural areas used sunscreen and shade less than individuals in urban areas while long pants/skirt wearing was more commonly reported among children in rural areas. This is largely consistent with prior studies (Cunningham et al., 2019; Fritschi et al., 1992; Nagelhout et al., 2019; Zahnd et al., 2010). The results also indicate that individuals in urban areas engaged in certain outdoor activities such as exercising outdoors, engaging in water activities, and going to amusement parks more often than individuals in rural areas. In contrast, individuals in rural areas were more likely to report engaging in outdoor activities such as farm work, yard work, and for children, sports. Prior studies have shown that participating in outdoor sports and other activities results in high UVR exposure (Snyder et al., 2020; Thieden et al., 2005). The current study extended past work by exploring the relationship between time spent by adults and children in outdoor activities and sunburn, the primary modifiable risk factor for skin cancer. In terms of the risk for sunburn based on outdoor activities, with the exception of playing sports, whereby rural adults had a higher sunburn rate than urban adults, there was not strong evidence of associations between parent or child sunburn occurrence and rural/urban status with particular outdoor activity types. Gender differences between rural and urban individuals, for both adults and children, were noted in terms sun protection practices used, outdoor activities, and risk for sunburn by outdoor activity. For instance, certain forms of sun protection (e.g., sunscreen) appear to be more frequently used by individuals in urban settings and by females. Additionally, some activities such as outdoor chores are more frequently reported by individuals in rural settings, particularly for women, girls, and boys. The different types of outdoor activities that urban and rural families engage in could contribute to differing levels of UVR exposure and sunburn occurrence, primary risk factors for the development of skin cancer later in life (Armstrong and Cust, 2017; Balk, 2011; Green et al., 2011; Wu et al., 2014). Prior work has demonstrated that UVR exposure is higher among individuals in rural settings when compared with individuals in urban settings (Naghout et al., 2021).

Limitations of the current study include that it was conducted with a small sample size in one geographic region of the U.S., and the sample was predominantly comprised of individuals who volunteered after receiving postal mailings and self-identified as non-Hispanic White in terms of their race and ethnicity. Future studies could include a larger, more racially and ethnically diverse sample of adults and children from other geographic areas and examine sunburn occurrence and outdoor activities across a range of seasons. Strengths of the study included the use of daily assessments of individuals' outdoor activities and sunburn occurrence, as well as the inclusion of an objective assessment of personal UVR exposure. In addition, the inclusion of participants from both rural and urban settings allowed for rural–urban comparisons on the outcomes of interest.

Skin cancer prevention interventions may need to be tailored for rural and urban families by addressing the different activities in which families are likely to engage, especially those in which they are more likely to receive a sunburn. Interventions could provide specific sun protection tips for those activities. For example, sun protection tips for adults (especially in rural areas) who have outdoor occupations or who

more frequently engage in farm or yard work will differ from tips for individuals who frequently exercise outdoors or participate in water activities such as swimming. Some intervention components could also be tailored based on participant gender, given differences observed in sun protection, tanning, outdoor activities, and sunburn risk. It may be useful, for instance, to recognize which forms of sun protection and tanning behaviors or outdoor activities may be more common by gender and/or age and to build on this in interventions by targeting sun protection strategies less often used and ensuring sun protection strategies recommended are compatible with peoples' chosen outdoor activities. In addition, interventions could be delivered in community or other settings, such as through sports teams or at community events, that would better reach individuals in the situations in which their outdoor exposure occurs. Existing interventions for individuals with occupational UVR exposure and through outdoor pools have demonstrated success (Buller et al., 2018; Glanz et al., 2002; Walkosz et al., 2018). Through continued research to understand the choices that individuals make in sun protection strategies, tanning, and outdoor activities, including in different geographic areas, skin cancer preventive interventions can be optimized to have the most potential for positive impact in mitigating risk for skin cancer.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author contributions

Study conception and design was completed by Yelena Wu, Bridget Parsons, Benjamin Haaland, and Elizabeth Nagelhout. Material preparation and data collection were performed by Bridget Parsons and Elizabeth Nagelhout. Data analysis was performed by Yeonjung Jo, Jonathan Chipman, Benjamin Haaland, and James Carrington. The first draft of the manuscript was written by Yelena Wu, Yeonjung Jo, Hannah Brady, and Ali Wankier. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institutional Review Board at the *University of Utah* [IRB_ 00106925].

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