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Participation in Cross-country Skiing in Finland under Climate Change: Application of Multiple Hierarchy Stratification Perspective

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Abstract

In Finland, cross-country skiing is part of the cultural heritage and an important leisure activity. However, its future is uncertain as, according to climate scenarios, southern Finland will be on the boundary of the winter snow cover. Behavioral responses to change raise the question of who will give up skiing and who will be able to continue the activity in a changed climate. In analyzing skiing participation and frequency, this study extends the multiple hierarchy stratification perspective (MHSP) by showing that the socio-demographic variables gender, age, socioeconomic status and living environment have an interaction effect. The results also indicate that female gender, a lower socioeconomic status and an urban living environment are associated with a higher sensitivity to climate change.

KEYWORDS: Population groups, sensitivity to climate change, individual adaptation, recreation participation

Introduction

Climate change and outdoor recreation have been investigated using empirical data and models to examine the potential consequences, i.e., changes in recreational behavior in response to possible climate change. Studies on climate change and skiing have mainly focused on downhill skiing (e.g., Breiling & Charamza, 1999; Harrison et al., 2001; Krämer, 2005; Moen & Fredman, 2005; Scott et al., 2005). Such studies have forecasted a considerable decrease in the number of skiers (Fukushima et al. 2002), particularly at lower altitudes (Breiling & Charamza, 1999; Irland et al., 2001). Loomis and Crespi (1999) also analysed

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cross-country skiing as a part of overall skiing activity. They forecasted a decrease in the number of visitor days to skiing areas, and found this activity to be among the most sensitive to changing climate.

In Nordic countries, cross-country skiing is an ancient way of moving from one place to another during the winter. In many cases, making snow artificially is a key adaptive mechanism in response to climate change (Scott et al., 2003; Aall & Høyer, 2005). However, traditional skiing uses extensive land areas with natural snow cover and cannot easily rely on artificial snow. In Finland, cross-country skiing is currently a part of the everyday winter lifestyle, as 38% of Finns annually participate in this activity (Pouta & Sievänen, 2001). Cross-country skiing has also been proven to be an excellent way of exercising and gaining health benefits. The opportunity to ski is part of the Nordic "everyman's right," the traditional right of open access that provides nearly unlimited possibilities for skiers to enjoy cross-country skiing in forests, fields and on ice-covered lakes. However, skiing mostly takes place on prepared ski trails in close-to-home recreation areas (even in larger cities) provided by the recreational administration agencies of municipalities. Thus far it has been possible to ski cross-country every winter in all parts of Finland using prepared ski trails. According to climate scenarios, the boundary of the winter snow cover will cross Finland in the future (Ruosteenoja et al., 2005), which means that snow cover in southern Finland will become increasingly less probable. The changing climate will have profound effects on skiing opportunities, particularly in the most densely populated southern part of Finland.

Climate change poses considerable challenges for both private and public cross-country ski centers and other service providers. For private enterprises the question is how to keep customers and business running under changing conditions. For public agencies providing recreation opportunities the challenges are more multifaceted, such as how to provide opportunities equally for all citizen groups, including those who have a weaker capacity to adapt to the changing climate. For public agencies promoting general health and wellbeing it is particularly important to know which population groups are likely to give up participation in skiing, and how to encourage these groups to find alternative physical activities. Therefore, for public agencies, information on who will be affected and who will be able to continue skiing is essential. In discussion on global warming, such questions are typically addressed at international or interregional levels (Thomas & Twyman, 2005). On smaller scales, such as the individual level or among population groups within a country, the issue of who will be affected has received little attention (Grothmann & Patt, 2005). In Finland, cross-country skiing is part of the cultural heritage and an important leisure activity. In this study we show that skiing activity is related to the individual socioeconomic profile. We also demonstrate that climate change will lead some people to give up traditional skiing and that the decline in the rate and frequency of participation will not occur equally among population groups.

The effects of climate change have been argued to be greater or possibilities to adapt to them smaller in communities with limited economic resources, a low level of technology, and poor information and skills (Grothmann & Patt, 2005). On the individual level, the capacity to adapt to climate change has been argued to be a function of access to resources (Adger, 2003). In empirical studies, adaptive capacity at the individual level has been found to be particularly related to ownership of property (Grothmann & Patt, 2005). Yohe & Tol (2002) have shown that poorer people and more densely populated areas are more vulnerable to change than the rich or sparsely populated areas. In leisure research, previous studies have not focused on the heterogeneity of behavioral change caused by climate change, although it can be assumed that different population groups face the effects of climate change very differently as their activity profiles and prerequisites for activities vary.

In leisure research, the heterogeneity of participation has been studied from a multiple hierarchy stratification perspective (MHSP) (Lee et al., 2001; Floyd et al., 2006). The MHSP implies that choices of leisure activities are influenced by a combination of several socio-economic variables that each affect the prerequisites for outdoor recreation. Combinations of these variables form a continuum of statuses from the lower end of the most disadvantaged group to the higher end of the most advantaged group. As these groups have different prerequisites for participation we can also assume that they will react differently to new constraints imposed by climate change.

Changes in skiing behavior may occur in measures such as which population groups will participate and how often they will ski. In this study, our approach is first to model cross-country skiing participation in terms of both the rate and frequency of participation. As a framework we utilize the MHSP to analyze the effect of gender, age, socioeconomic status and living environment on skiing behavior. Second, we extend the MHSP framework to examine the interaction between these socio-demographic explanatory variables. Our third objective is to identify those population groups that will be most strongly affected by climate change. This is achieved by defining the socioeconomic variables that interact with climate variables in explaining skiing behavior.

Our study adds to the literature by applying the MHSP approach to both the rate and frequency of participation in skiing and by testing the interaction between socioeconomic variables in MHSP-based participation models. Furthermore, our approach is the first attempt to show which population groups are the most likely to change their recreational behavior because of climate change. The data used to construct the models were obtained from the national inventory of outdoor recreation in Finland. In the empirical section, in addition to participation models, we present scenarios of skiing participation based on climate and socioeconomic scenarios. The recreational participation scenarios enable us to predict how current patterns of skiing behavior, participation rates and frequencies of participation will follow changes in climate and demography in the near term (2007-2020), mid-term (2021-2050) and long term (2051-2080), and how population groups are likely to differ in their future participation in cross-country skiing.

Multiple Hierarchy Stratification Perspective and Sensitivity to Climate Change

Many previous studies by leisure researchers have focused on the effects of socio-economic variables such as gender, age, socioeconomic status and ethnicity on participation (reviewed by Manning, 1986; Lee et al., 2001; Cordell, 2004). The combination of these factors has led to the multiple hierarchy stratification perspective, which enables understanding of the structural inequalities in recreational participation (Lee et al., 2001; Floyd et al., 2006). This perspective presents the idea that disadvantaged statuses, such as an older age, female gender and lower socioeconomic status, are sources of inequality, and form a "stratification continuum" (Markides et al., 1990). According to the continuum, elderly minority women with a lower socioeconomic status have four separate statuses that create a disadvantage and they tend to be at the bottom of the multiple hierarchy of recreational participation. In contrast, younger or middle-aged males of the dominant ethnic group having a middle or higher socioeconomic status are located at the top of the hierarchy and have a high probability of participating in recreational activities. The MHSP states that the combined effects of multiple statuses of inequality are more intense than the effect of any single status.

The MHSP has particularly been used to explain leisure participation (Cutler Riddick & Stewart, 1994; Floyd et al., 2006), but also to explain leisure preferences (Shinew et al., 1995) and leisure benefits (Phillip, 1999). The approach in testing the stratification perspective has been to use logistic regression analyses and to apply the estimated models in calculating participation probabilities for the different statuses in the hierarchy. In the models, the four factors have explained participation as separate variables. However, some studies have also revealed that there might be interrelationships between these variables. In the study of Phillips (1997), race and gender interrelated in explaining leisure benefits, while gender, race and social class interrelated according to Shnew et al. (1995), and Johnson et al., (1998) reported the interaction of race and income. In studies explaining participation in leisure activities with the MHSP, the interactions of explanatory variables have not typically been included in the logistic model. The traditional MHSP does not state whether the effect of one factor is stronger in some classes of another factor. The empirical applications have simply defined the variables that together reduce participation the most, and have shown that the additive effect of a combination of variables is greater than the effect of a single variable. However, one could assume, for example, that age would have a stronger effect on recreational participation among those with a low socioeconomic status, or among females. Allowing interaction between status variables provides a new insight into the mechanisms underlying inequality in participation.

In Finland, where the population is ethnically relatively homogeneous, over ninety percent of people belong to the main ethnic group, while the remaining ethnic groups are very small. Ethnicity is consequently not a relevant factor in understanding differences in recreation at the population level. Instead, several studies have demonstrated that participation in recreational activities in Finland particularly differs between urban and rural populations (Pouta et al., 2006; Sievänen, 1995; Pouta & Sievänen, 2001). In this study we utilize the multiple hierarchy stratification perspective, but the variables we focus on are gender, age, socioeconomic status and the urban-rural difference.

The MHSP includes the idea that leisure resources are compromised as a result of multiple disadvantaged statuses (Markides et al., 1990). Following this idea we can assume that constraints on resources, such as a shortage of snow as a constraint on winter activities, particularly affect those groups with multiple disadvantaged statuses. This assumption is also supported by the literature. In economic terms, the production of skiing experiences is typically understood as a form of production in a household (e.g. Feather et al., 1995; McConnell, 1999 based on Becker, 1991). Skiing experiences are a final good that is produced by allocating household resources such as skills, time and monetary resources to the activity. Climate factors such as the depth of snow and temperature during the skiing season, as well as individual characteristics, affect the production of skiing times. An individual decides to participate in skiing if the enjoyment from skiing exceeds the enjoyment (utility) from alternative activities within the limits of time and the monetary budget of the individual. The structural constraints of skiing participation are often related to the costs: expensive equipment and clothing and a lack of money or of low-cost skiing holidays (Gilbert & Hudson, 2000). Traveling to a skiing resort also has time costs. The rate of participation depends on the supply of appropriate areas or resources. In the case of cross-country skiing, climatic factors are even more important than man-made resources, as skiing is possible on natural snow without a constructed and managed ski trail.

Assessment of the effects of climate change provides an additional insight by decomposing cross-country skiing participation into two components: the overall rate of participation within a time period and, for those who participate, the frequency of participation (number of skiing days) in that period. In order to participate, skiing skills and equipment are needed. A basic investment or threshold therefore exists for skiing participation, and different factors may affect the overall decision to participate and the decision on the skiing frequency (compare Huhtala & Pouta, 2006; Neuvonen et al., 2007).

On an individual level, it is possible to adapt to a new climate situation and to a deterioration in skiing conditions by traveling to more distant locations. It is also possible to learn new skiing skills, such as skate skiing (free style), that better suit temperatures above freezing. Nevertheless, this new style also demands new equipment, and adaptation is therefore easier for those who have the time, money and ability to learn new skills. These components of production are also connected with the socioeconomic profile of an individual. Having these adaptation mechanisms in mind we can assume that various socioeconomic groups will differ in their participation under changed climatic conditions depending on their time, skill and income constraints.

Table 1 summarizes assumptions based on speculation and empirical results from previous Finnish or international studies and shows how the time, money and skill components of producing skiing experiences relate to sources of inequality in the MHSP. The association between female gender and lower incomes (Suomen tilastollinen vuosikirja 2005) and more severe time constraints because of the greater time spent on household work and child care (Pääkkönen & Niemi, 2002; Berg, 2005; Piekkola & Ruuskanen, 2007) is also clear in Finland. A younger age can be assumed to relate to a greater readiness to learn new skills (Sugerman, 2002), but to tighter income and time constraints (Suomen tilastollinen vuosikirja, 2005). A higher socioeconomic status typically relates to a higher level of education and better ability to learn new skills. Although income constraints on adaptation are less in the higher socioeconomic group, the time constrain is tighter because of the higher opportunity cost of time.

The rural-urban continuum relates to adaptive capacity via access to recreational resources. In rural settings, access to natural resources, including those for skiing, demands less time and money (Pouta & Sievänen, 2001), but the availability of commercial services such as snowmaking or public services such as prepared ski trails is greater for people living in more densely populated areas. For Finns, the average distance from home to a prepared ski trail is about 1.5 km. In larger cities this distance is 1.4 km and in rural municipalities 2.5 km (Pouta & Sievänen, 2001). However, in rural municipalities this difference is balanced by the better opportunities to ski without a prepared ski trail. Skiing without prepared trails is

TABLE 1

Accumulation of sensitivity to climate change from resources enabling participation in skiing in various demographic groups. (+ higher sensitivity, - lower sensitivity, 0 unknown effect)

	Gender		Age		Socioeconomic Status		Rural-Urban	
Determinants of sensitivity to climate change	Male	Female	Young middle	Elderly	High	Low	Rural	Urban
Time	–	+	+	–	+	–	–	+
Skills	0	0	-	+	-	+	0	0
Lower monetary expenses or higher income	–	+	+	–	–	+	0	0
Total sensitivity	–	+	+	–	–	+	– ?	+ ?

valued by some skiers and it particularly relates to other rural activities such as fishing and hunting. These rural-urban differences in resources emphasize the importance of testing whether rural-urban variation could be one status variable in the MHSP framework.

Hypotheses and Methodological Approach

We can summarize our hypotheses as follows:

H1: Female gender, an older age, a low socioeconomic status and an urban living environment decrease the rate and frequency of participation in cross-country skiing.

H2: The negatively-affecting socioeconomic statuses interact and have a cumulative effect on participation.

H3: The negatively-affecting socioeconomic statuses interact with climatic factors, i.e. there is a greater sensitivity to climate change among those with multiple disadvantaged socioeconomic statuses.

Here, we test these hypotheses by estimating both the rate of participation in skiing and the frequency of participation (number of skiing days) from national recreation participation survey data. First, we test whether the variables in our variant of the MHSP are significant in the models (H1). Second, we test whether their interactions significantly affect the rate and frequency of participation (H2). The third step is to analyze whether the interaction of variables in the MHSP and climate variables is significant (H3). In these steps our purpose is not to add climate variables to the MHSP framework, which focuses on differences between population groups. However, we aim to show that climate variables also affect participation in recreational activities and that these climate variables can have a stronger effect on some population groups defined with the MHSP than on others.

Our approach is to estimate two sets of models: one set of three participation rate models, and a second set of three models for participation frequency. In the first models of both sets we incorporate climate variables as well as variables related to the MHSP. In the second models incorporating interactions of status variables of the MHSP we apply the extension of the MHSP by testing whether certain variables are interdependent and whether their effect differs or is clearer in connection with other statuses. In the third models of both sets, incorporating the interaction of climate and status variables, we attempt to reveal those population groups that are most likely to change their recreational behavior because of climate change. The participation models also reveal those status groups that are most likely to give up skiing and those that are least likely to change their behavior.

After these tests we clarify the effect of socioeconomic and climate variables by comparing the participation estimates between high and low status groups in a multiple hierarchy. As individuals respond to climate variables by adjusting their rate and frequency of participation in skiing, the effect of climate change on these measures is estimated from the models. Using estimated participation models and climate and socioeconomic scenarios from previous research, we extrapolate skiing participation in the near term (2007-2020), mid-term (2021-2050) and long term (2051-2080). We demonstrate the difference in behavioral change between these groups in selected time horizons.

Data and Statistical Models

Data of the study

The data on skiing behavior under varying climate conditions were obtained from the national inventory of outdoor recreation in Finland, which included information on the recreational behavior of Finns aged 15–74 years (Virtanen et al., 2001). The data were collected bimonthly via telephone interviews from August 1998 to May 2000 as 12 split samples and covered two winter and summer seasons. In telephone interviews of the national inventory (10,651 interviewees) the response rate was 84%. The telephone interview included questions on participation in ninety recreational activities. The data were found to be representative of the population with respect to age and gender (Virtanen et al., 2001).

In the telephone interview the respondents indicated whether they had skied cross-country at least once during the previous 12 months. In a separate item, respondents were asked how many days they had spent skiing during the previous 12 months. The climate variables that are important in explaining recreational behavior and that were used in developing skiing participation models were the mean air temperature and snow depth in the preceding 12-month period (cf. Fukushima et al., 2002). To build participation models that included climate variables we connected observed climate data from the Finnish Meteorological Institute and survey responses by taking into account the time and space dimensions. With respect to time, we connected the observed weather data from the 12-month period before the survey to each survey response. As the survey data were collected every second month during a two-year period, we obtained data for 12 different time periods. With respect to space, the weather data from 20 weather stations were connected to the survey responses based on the home municipality of each respondent and the province where each station was located. The importance of weather conditions near the respondents' homes was justified, as over half of the skiing days took place as day trips from respondents' homes. As a result we obtained a single data set that included variables for skiing participation and weather information during the 12-month period prior to the survey for each respondent. In the survey, 41.3% of the respondents indicated that they had participated in cross-country skiing at least once in the preceding 12 months.

The respondents' background variables were obtained in the telephone interviews and from the national population register. For the MHSP we recoded the socioeconomic variables to create the basic status variables. The gender of the respondents was used as measured. The respondents were divided into two groups based on their age: respondents under 60 and those aged 60 years or older. Respondents who were entrepreneurs or employees were categorized into the higher socioeconomic group, while other respondents (manual workers, farmers, unemployed, students, pensioners and others) were coded in the lower socioeconomic group. These groups also reflected the incomes of the respondents, which were higher among those in the higher socioeconomic group than in any lower socioeconomic subgroups. The urban-rural variable was generated from the respondents' home municipality size in terms of the number of inhabitants. Respondents living in a municipality with over 100 000 inhabitants were coded as urban. This definition included respondents from the six largest cities in Finland. To analyze whether the effect of a socio-demographic variable is stronger or weaker in the groups of some other socio-demographic variables, six interaction variables (gender x age, gender x socioecon, gender x urban, age x socioecon, age x urban, socioecon x urban) were formed.

In the following estimations, two variables describing climate conditions were included in the model: the mean snow depth and the mean temperature. Special emphasis was placed on modeling the effects of climate in different socioeconomic groups by constructing interactions between climate and socioeconomic variables and including them in the models when the coefficient was significant.

Statistical models

Participation in cross-country skiing was modeled using logistic regression analysis because the dependent variable was dichotomous: participation or non-participation within the 12-month period prior to the survey. Significance tests for a single coefficient were based on the Wald test (Hosmer and Lemeshow, 2000, p. 37), and the likelihood ratio test was used to examine the significance of the models (Hosmer and Lemeshow, 2000, p. 146). We interpreted the models with the help of estimated probabilities.

A model for participation frequencies was constructed using negative binomial regression (Cameron and Trivedi, 1998). For skiing, the frequency of participation has the form 0, 1, 2 … times per year, and a Poisson regression model is commonly used to analyze such count data. By comparison, the negative binomial regression model stretches the assumption of the equality of the variance and mean of the dependent variable in Poisson distribution by allowing the variance to deviate from the mean. Because the variance in our data differed from the mean, we gave preference to a negative binomial regression model over a Poisson regression model. The model for participation frequencies focused on the nonzero participation times, and the data were truncated from zero (Cameron and Trivedi, 1998, p. 117–121), meaning that the zero values were excluded from the model.

The pseudo R^2 was applied as a measure of the goodness of fit for both the logistic regression model and the negative binomial regression model. The pseudo R^2 is defined as $1 - L_m/L_0$, where L_m is the log likelihood for the estimated model, and L_0 is the log likelihood for a model that includes only a constant (e.g. Hosmer and Lemeshow, 2000, p. 165–166; Cameron and Trivedi, 1998, p.155). Another criteria for selecting the best model (both participation and participation frequencies) was to avoid multicollinearity in the models. Because explanatory variables correlated with each other, some of the variables were excluded from the models.

We applied binary logistic and negative binomial regression models in three settings. We first estimated the model using the basic variables of our MHPS, namely gender, age, socioeconomic status and urban to rural variation, and two climate variables, the mean temperature and depth of snow. In the second model we tested the extension of the MHPS with interaction between socioeconomic variables (concerning interaction variables in regression models, see e.g. Hosmer and Lemeshow, 2000, p. 70-74; Aiken and West, 1996). The third model focused on testing the inequality aspects of climate variables by including interactions between climate and socioeconomic variables.

Scenarios and Extrapolation of Future Skiing Participation

To create scenarios for cross-country skiing, we used the models for present outdoor recreation as a basis for predicting future outdoor recreational behavior. We assumed that the relationship between climate and recreational behavior and socio-demographic factors remains stable. We then extrapolated the models beyond the present by including socioeconomic and climatic scenario values that applied to the whole population. To produce skiing scenarios within the most and least sensitive socioeconomic groups we used climate scenarios alone, as the socioeconomic profile of the group was assumed not to change.

For the whole population we applied population scenarios to account for the shifts between population groups. Forecasts for annual population growth rates were applied to convert participation information to the level of the future population (Carter et al., 2005). The age distribution follows the demographic forecast (Tilastokeskus, 2004). The population scenario of Statistics Finland (Tilastokeskus, 2004) also provides a baseline to forecast change in the proportion of the population living in urban areas and the socioeconomic distribution. We had no reason to expect a change in the gender distribution.

Based on international climate scenarios, Ruosteenoja et al. (2005) have constructed national scenarios for changes in mean surface air temperature and snow depth. Projected changes in mean surface temperature for the short term (2007-2020) are minor, indicating a 0.9 °C increase (A2 high emission scenario[1]) relative to the period 1971-2000. Snow depth is predicted to decrease by 16% at Helsinki-Vantaa weather station and 8% at Sodankylä weather station from 1991-2020 relative to 1971-2000. Long-term annual warming of the surface air temperature by 5.0 °C is projected for the period 2071-2100 relative to the period 1971-2000. Figure 1 illustrates the predicted change in average temperature (Kellomäki et al., 2005 based on Ruosteenoja et al., 2005). The annual snow depth is predicted to decrease by 48% at Sodankylä and by 78% at Helsinki-Vantaa over the same period.

Results

Participation in Skiing

To empirically approach the three hypotheses we began by estimating the participation model for cross-country skiing. In Table 2 the model for socioeconomic variables (model 1) indicates that the basic MHSP approach applies to participation in cross-country skiing. The female gender, a higher age, lower socioeconomic status and urban home municipality all reduce the probability of participation in skiing. The coefficients for variables revealed

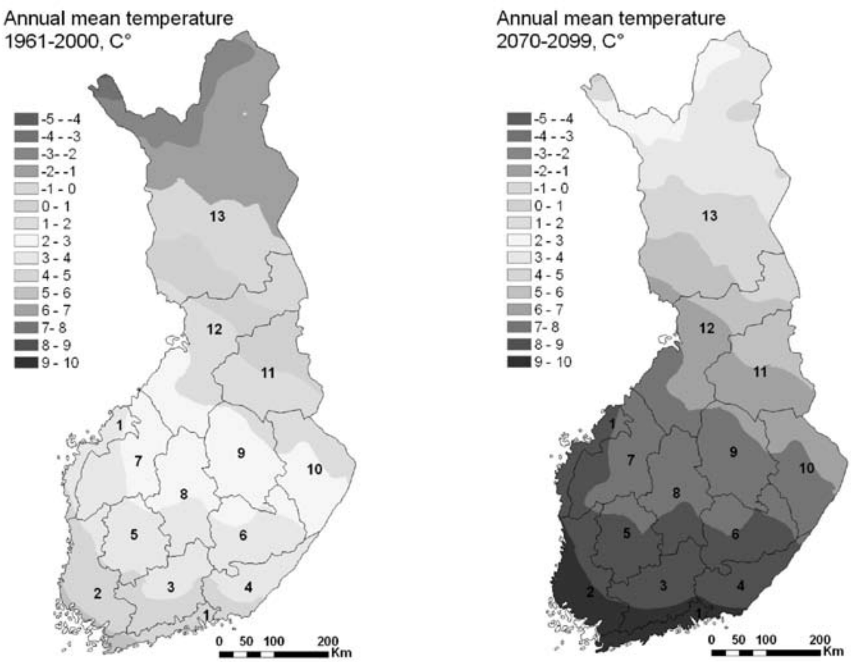

FIGURE 1. The scenario for the annual mean temperature from 1961-2000 to 2070-2099 (Kellomäki et al., 2005 based on Ruosteenoja et al., 2005).

[1] Scenario A2, in line with more resent analysis of climate change in the Baltic Sea area (The BACC Author Team, 2008)

that a low socioeconomic status and high age particularly reduced the rate of participation. Climate variables also had a significant effect; the lower the mean temperature and deeper the snow cover, the higher the participation rate.

Model 2 tested the extended MHSP, i.e. the effect of those interactions between socioeconomic variables that were, in addition to the basic variables, significant explanators ($p < 0.01$) of skiing participation. These were the interactions between a greater age and an urban living environment, a greater age and female gender, and the interaction between a low socioeconomic status and an urban living environment. The last two of these interactions followed the assumptions and reduced the participation in skiing. Surprisingly, the interaction between a greater age and an urban living environment had a positive impact on participation. When interaction variables were included the coefficient of the gender variable was no longer significant. This implies that the effect of gender particularly relates to a

TABLE 2

Socioeconomic and climate factors affecting the rate of participation in skiing according to binary logistic regression models

	Model 1 MHSP and Climate		**Model 2** Extended MHSP and Climate		**Model 1** Climate Equality Test	
	Co-efficient	p-value	Co-efficient	p-value	Co-efficient	p-value
Constant	0.429	0.000	0.369	0.002	0.300	0.013
Gender (female1, male 0)	-0.089	0.033	-0.029	0.510	-0.093	0.026
Age (over 60= 1, under 60 = 0)	-0.436	0.000	-0.326	0.000		
Socioeconomic status (lower 1 higher 0)	-0.580	0.000	-0.504	0.000	-0.597	0.000
Rural-urban (urban 1 rural 0)	-0.325	0.000	-0.230	0.003		
Mean temperature, annual (ºC)	-0.096	0.018	-0.096	0.000	-0.070	0.000
Depth of snow, annual (cm)	0.016	0.005	0.015	0.002	0.018	0.000
Age over 60 x urban (1, others 0)			0.567	0.000		
Age over 60 x female (1, others 0)			-0.424	0.000		
Low socioecon. x urban (1, others 0)			-0.280	0.006		
Age over 60 x mean temperature					-0.080	0.000
Urban x mean temperature					-0.063	0.000
N	10 138		10 138		10 138	
Participation, %	41.3		41.3		41.3	
Correctly classified, % (cut-off point 0.50)	61.9		61.9		61.8	
Log-likelihood (model)	-6586		-6572		-6594	
Log-likelihood (constant)	-6836		-6836		-6836	
Chi2 (Likelihood Ratio)	474.510		528.373		483.448	
p-value	<0.0001		<0.0001		<0.0001	
Pseudo-R2	0.037		0.039		0.035	
Nagelkerke R2	0.062		0.069		0.063	

greater age, i.e. that younger women do not participate less than men, but in the group of older women participation is less likely.

The model to test the equal effect of climate change (model 3) was estimated by including those variables from the climate-socioeconomic interactions that had significant coefficients ($p < 0.05$). These were mean temperature together with a greater age and mean temperature together with an urban living environment. The negative signs of the interaction variables indicate a stronger negative effect of the temperature variable and higher likelihood of giving up skiing among older respondents and those in an urban living environment compared to the reference group.

Second, for those who participated in skiing we constructed models explaining skiing frequency measured as the number of skiing days (Table 3). Model 1 tested the basic MHSP and revealed that the effect of socioeconomic variables on participation days differed little from the variables explaining general participation. Of these variables, female gender, a lower socioeconomic status and an urban living environment decreased the participation days. In contrast to the participation probability model, an older age increased the number of skiing days for participants. Of the climate variables, mean temperature was significant and positive, reflecting a decreasing frequency of participation. Snow depth was not statistically significant and was excluded from the model.

In model 2 we tested whether any interactions between socioeconomic variables associated significantly with the number of skiing days. The only significant interaction was

TABLE 3

Socioeconomic and climate factors affecting the frequency of skiing according to a truncated negative binomial regression model.

	Model 1 MHSP and Climate		**Model 2** Extended MHSP and Climate		**Model 1** Climate Equality Test	
	Co-efficient	p-value	Co-efficient	p-value	Co-efficient	p-value
Constant	3.421	0.000	3.385	0.000	3.252	0.000
Gender (female1, male 0)	-0.326	0.000	-0.256	0.000		
Age (over 60= 1, under 60 = 0)	0.139	0.014	0.134	0.017	0.135	0.018
Socioecon. status (lower 1 higher 0)	-0.070	0.029			-0.062	0.050
Rural-urban (urban 1 rural 0)	-0.244	0.000	-0.246	0.000		
Mean temperature, annual (ºC)	-0.087	0.000	-0.088	0.000	-0.052	0.000
Low socioecon. x female (1, others 0)			-0.121	0.010		
Female x mean temperature					-0.073	0.000
Urban x mean temperature					-0.040	0.000
Alpha coefficient	1.213	0.000	1.210		1.219	0.000
n[1]	4068		4068		4068	
Log-likelihood (model)	-15826		-15952		-15832	
Log-likelihood (constant)	-7602		-47939		-47756	
Chi^2 (Likelihood Ratio, degrees of freedom 1)	63550		63975		63847	
p-value	0.000		0.000		0.000	
Pseudo R^2	0.668		0.667		0.668	

[1] Non-participants are excluded.

that between female gender and a lower socioeconomic status. Inclusion of this variable in the model also resulted in socioeconomic status no longer being significant. This implies that among the skiers in the lower socioeconomic group, women ski less often than the average.

In the third model we tested sensitivity to the climate factor (mean temperature) in terms of skiing times within socioeconomic groups. With this model we determined that higher temperatures were associated with a lower number of skiing days, particularly among women and those in the urban population.

Predictions of Future Skiing

The extended MHSP models (model 2) from Table 2 and Table 3 were used to estimate the current rate and frequency of skiing participation for the whole population, and for two groups that were at opposite ends of the MHSP status continuum: 1) for the group of older females with a lower socioeconomic status living in cities and 2) for the group of younger males with a higher socioeconomic status living in small towns or rural areas (Table 4). The probability of participation was 40% for the whole population, 25% for the group with a lower participation rate and 53% for the group with a higher participation rate. The number of skiing days per skier also varied from 13 days for the lower status to 21 days for the higher status group. The figures for skiing days per individual in the group (including non-skiers) capture the effect on both the rate and frequency of participation, producing considerable differences between groups from 3.5 days per individual at the lower extreme to 11.8 days at the higher end of the status continuum.

Based on the interaction of socio-demographic and climate variables, the sensitivity to climate change is associated with the same variables as participation, excluding the socio-economic variable (Table 5, Figure 2). Table 5 shows the sensitivity to climate change from the measurement time to the period of 2051-2080 for the group with a higher sensitivity, i.e. older females living in cities, and that with a lower sensitivity, i.e. younger males living in small towns or rural areas. These participation figures are based on model 3 (in Tables 2 and 3) and predictions for the climate and socioeconomic status distribution. Other socioeconomic predictions were only used for the whole population. On the population level, the participation rate in the long term is estimated to decline by 36% and the participation days

TABLE 4

Estimated current participation based on the extended MHSP (model 2 from Tables 2 and 3).

	Total population	Population with a low participation rate (low socioecon. urban older female)	Population with a high participation rate (high socioecon. non-urban younger male)
Present state			
Population	3 896 900	52 900	398 000
Proportion of skiers %	40	25	53
Number of skiers	1 552 100	13 100	210 600
Skiing days/skier	17	13	21
Skiing days/skier with population mean	18	14	22
Total number of skiing days	28 932 900	185 800	4 720 400
Skiing days per individual	7.4	3.5	11.8

per skier by 39%. For the group with a higher sensitivity the participation model predicted a decline in the participation rate from the current 20% to a long-term estimate of only 9%. At the same time, the average skiing days per participant is predicted to decline in this group from 12.8 to 7.1, which corresponds to a 54% reduction. Table 5 and Figure 2 also show the less dramatic decline in the group with a high capacity to adapt, in which the proportion of skiers is predicted to decline by about 23% and the number of skiing days by about 23%.

Discussion and Conclusion

This study developed models for the rate and frequency of participation in cross-country skiing by applying the MHSP. It also extended the application of the MHSP from the approach of Lee et al. (2001) to explain the number of skiing days. Lee et al. recognized that stratification structures can vary regionally. We applied the approach in the rather homogeneous social setting of Finland by replacing the race variable with the urban–rural dimension. Furthermore, we tested an extension of the MHSP in which the variables affecting participation were allowed to interact.

Our results are consistent with those of previous studies reporting the negative effect of female gender, age, and a lower socioeconomic status on recreational participation. However, while Lee et al. (2001) observed that an age of over 65 was the strongest demographic variable affecting participation, in our case a lower socioeconomic status had an even greater effect than age. As in previous studies on hunting and berry picking (Stedman & Heberlein,

TABLE 5

Socioeconomic and climate factors affecting the frequency of skiing according to a truncated negative binomial regression model.

	2000	2007-2020	2021-2050	2051-2080
All*				
Proportion of skiers, %	40%	36%	34%	26%
Skiing days per skier	18.1	16.1	14.5	11.0
Change in the proportion of skiers, %		-11%	-17%	-36%
Change in skiing days per skier, %		-11%	-20%	-39%
Higher sensitivity** (low socioecon. urban older female)				
Proportion of skiers, %	25%	20%	16%	9%
Skiing days per skier	15.3	12.8	10.9	7.1
Change in the proportion of skiers, %		-21%	-35%	-65%
Change in skiing days per skier, %		-16%	-29%	-54%
Lower sensitivity** (high socioecon. non-urban younger male)				
Proportion of skiers, %	55%	51%	49%	42%
Skiing days per skier	22.3	21.0	19.9	17.2
Change in the proportion of skiers, %		-6%	-10%	-23%
Change in skiing days per skier, %		-6%	-11%	-23%

* Based on climate scenarios and scenarios for all socioeconomic variables
** Within-group prediction based on climate scenarios

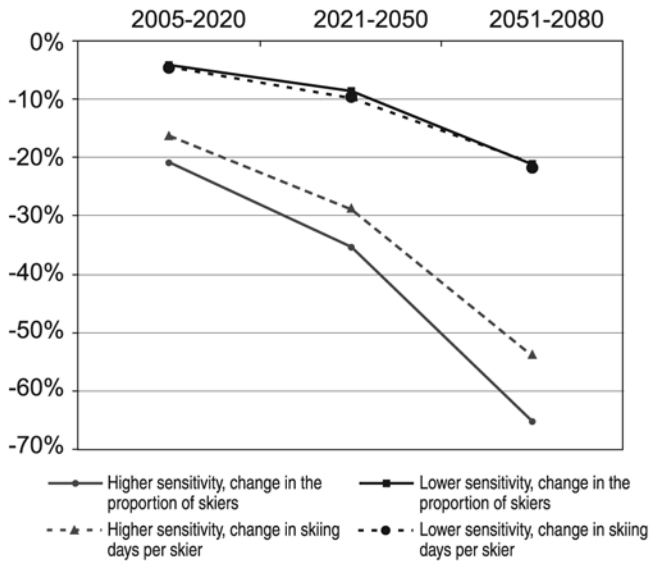

FIGURE 2. Percentage changes in the rate and frequency of participation in cross-country skiing in groups with a low and high adaptation capacity.

2001, Pouta et al., 2006), living in an urban environment also reduced the rate of participation in cross-country skiing. However, our study revealed a greater frequency of participation among older people, which was opposite to expectations, and that socioeconomic factors reducing participation in skiing had a cumulative effect. The interaction between age and female gender and between a lower socioeconomic status and an urban living environment particularly decreased the rate of participation. In the case of participation frequency (skiing days), the significant interaction was that between a lower socioeconomic status and female gender. As the significant variables differed between the models of participation rate and frequency, we can conclude that the relevant factors underlying participation decisions differ from those underlying decisions on the frequency of participation.

We tested whether sensitivity to climate change was associated with the socioeconomic variables of the MHSP model. Although there was a decrease in the rate and frequency of participation in groups at both the higher and lower end of the MHSP status continuum, the decrease was approximately three times stronger at the lower end. Urban people and those with a higher age were particularly sensitive to temperature in terms of the rate of participation, while urban skiers were also sensitive to temperature in their frequency of participation. These results are in line with the discussion on individual adaptation related to lower resources presented in previous studies (Yohe & Tol, 2002). Furthermore, our study revealed that the female gender associated with a higher sensitivity to climate factors in terms of participation frequency.

The results indicated that the rate and frequency of participation in cross-country skiing are highly dependent on low temperature as a precondition for the activity. In practice, future adaptation of winter recreation and nature-based tourism to climate change will take place in two ways: people will adapt autonomously and reactively by changing their recreational and travel behavior to suit the new conditions, and the supply of recreational and tourism services will adapt to the new climatic conditions. In this study we were able to estimate the possible change in autonomous behavior; however, we did not focus on any changes in the supply of recreational opportunities. This study provides baseline information on the possible changes in participation in cross-country skiing if no changes take place in supply in terms of man-made facilities or technological improvements in the environment, such as ski trails prepared with artificial snow.

Individual adaptation strategies to continue skiing include the use of sites with artificial snow or travel to more distant locations. Both of these strategies are energy consuming and do not follow the principles of sustainable mobility and leisure, in which the focus is on using and providing possibilities for a good quality of life near one's home (Dubois & Ceron, 2005). In Finland, cross-country skiing is strongly recommended for all population groups as a healthy form of exercise. From the health perspective there is a need to enhance the skiing opportunities of those groups that particularly face health problems related to a shortage of exercise. Another option is to focus on compensative activities for those who will give up skiing and to guarantee opportunities for these compensative activities.

Our predictions were based on current behavioral patterns. Behavioral changes, including those related to climate change, can be revealed most accurately by monitoring trends in behavior. Panel data that include several measurements of participation, although expensive and laborious to collect, would facilitate an in-depth analysis of cause and effect in the relationship between climate conditions and participation patterns. Furthermore, based on our cross-sectional data, it is impossible to separate the effects of age and cohort (cf. Spence, 2002). At present, about 94% of Finns report having cross-country skiing skills (Pouta & Sievänen, 2001). Among the younger generation (15-24 years) the percentage is 91%. Inexpensive opportunities close to home are particularly important for children who are just learning to ski. As a result of decreasing close-to-home opportunities, raising children to ski may in the future no longer be so common (cf. Bürki et al., 2005). If there is a change in learning patterns, the effect of climate change might be stronger among younger cohorts than our results imply. Because participation trends describe past behavior, investigations measuring and explaining behavioral choices that provide an insight into future behavior also are needed. Preference studies would also provide information for the sport and recreation industry and public sector agencies, enabling them to gain some understanding of future leisure behavior and choices of recreation activities and places, and the choice patterns of different population groups.

In addition to socioeconomic inequality in the sensitivity to climate change, Finns face geographic inequality. Particularly the most populated southern part of the country will face a shortage of snow in the future. Skiing tourism is well established in Northern Finland, but expectations towards the development of nature tourism are stronger in southern parts of the country. The expected future change in climate and the declining snow cover related to decreasing opportunities for winter activities will not support this development, and neither will it support skiing as an everyday leisure activity. In the future it is probable that cross-country skiing will not remain a part of the Nordic way of life and a symbol of the national culture, but will instead become an activity for those who have the resources and possibility to travel to ski resorts. In this way, climate change will lead to a loss of cultural diversity and the increased unification of the leisure culture in Europe: Northern European leisure patterns will merge with those of Central Europe.

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