Oregon's Statewide Comprehensive Outdoor Recreation Plan (SCORP)

Health and Recreation Linkages in Oregon: Physical Activity, Overweight and Obesity

FINAL REPORT
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PHASE 2
Outdoor Recreation in Oregon: The Changing Face of the Future
A research agenda for the 2008-2012 Oregon Statewide Comprehensive Outdoor Recreation Plan (SCORP)

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EXECUTIVE SUMMARY

This project tests the hypothesis that people in Oregon with ready access to outdoor recreation opportunities are healthier than people residing in areas without access to such resources. Information about the health-related benefits of outdoor recreation is useful to managers and policymakers who are increasingly challenged to both describe the benefits resulting from recreation projects and to allocate their scarce resources to providing high-quality recreation opportunities in addition to other public services.

Overweight and obesity are associated with increased health risks for certain chronic diseases such as coronary heart disease, type 2 diabetes, various cancers (e.g., endometrial, breast, and colon cancers), among other diseases and disorders. Physical activity reduces health risks, regardless of weight class. There is strong evidence of an inverse, linear relationship between physical activity and reductions in all-cause mortality, total cardiovascular and coronary heart disease incidence and mortality, type 2 diabetes mellitus, and colon cancer. Physical activity also may help prevent weight gain, but appears to be ineffective alone in promoting weight loss. Therefore, getting sedentary people physically active would significantly reduce the health care burden associated with physical inactivity, overweight and obesity.

The US Centers for Disease Control and Prevention, American College of Sports Medicine, and the US Surgeon General recommend a minimum of 30+ minutes of moderate-level or 20+ minutes of vigorous-level exercise, cumulatively, most days of the week. Recreation can contribute to the accumulation of the recommended levels of physical activity. Recreation as physical activity is promoted through accessibility to parks and equipment (distance to opportunities), opportunities (places to recreate), and the quality and diversity of opportunities in natural settings.

In 2005, Oregon was doing better or at least doing no worse than the US on health prevalence measures of physical activity, overweight and obesity. The proportion of Oregon adults that are physically active in their leisure time was 56% compared to the US at 49%. Oregon was identical to the US in the proportion of adults that were overweight (37%), while rates of obesity were slightly lower than the US (20% v. 22%, respectively). These general patterns of health prevalence measures between Oregon and the US held up across gender and age classes. Trends in the proportion of adults that are physically active, overweight or obese are all increasing at nearly identical rates between Oregon and the US.

Rates of physical activity, overweight and obesity varies across Oregon's counties. The average county proportion of physical activity increased from 44% in 2001 to 54% in 2005. The average county proportion of overweight slightly decreased from 39% in 2001 to 38% in 2005. The average county proportion of obesity slightly increased from 22% in 2001 to 24% in 2005. Some counties' proportions of physical activity decreased and some counties' proportions of overweight and obesity increased during this period.

Just as health prevalence measures vary across Oregon's counties, recreation opportunities and participation rates vary across counties. Hiking trail miles averaged nearly 270 miles per county, urban trail miles (jogging, walking and biking trails) averaged 106 miles per county, and

recreation facilities (sports fields and courts, swimming pools, golf courses, etc.) averaged 263 per county. The average proportion of adults per county participating in trail or off-trail activities (hiking, biking, etc.) was 49%, it was 73% for road and street activities (running, walking, etc.), and it was 47% for outdoor sports and games activities (golf, baseball, softball, etc.). The average number of days per household per year participating in the activity groups were 6 days for trail or off-trail activities; 31 days for road and street activities; and 8 days for outdoor sports and games activities.

Three multivariate regression models were estimated that measure associations between health prevalence measures and recreation supply and demand, while holding other moderator effects (demographics) constant. Results show that recreation supply and demand are strongly associated with higher rates of physical activity, somewhat associated with lower rates of overweight, and weakly associated with rates of obesity. The more hiking and urban trail miles per household were associated with increased rates of physical activity. More days spent in trail, road and sports related activities were associated with higher physical activity rates. Hiking trail miles per household were negatively associated overweight, but not obesity. Days spent in trail and sports activities were negatively associated with overweight, while only days spent in trail activities was negatively associated with obesity. These results linking recreation supply and demand with physical activity is important given physical activity attenuates health risks regardless of weight class.

The results of this analysis when combined with evidence from the literature support several general recommendations for recreation managers.

- Support close-to-home non-motorized trail development;
- Identify high priority counties for trail development based on projected health status and direction of change in health status, in particular, rates of physical activity;
- Promote the use of existing trail networks by providing information on existing trails;
- Market the health benefits of outdoor recreation, but note the importance of nutrition in a weight loss regimen;
- Target at-risk people and communities by identifying their preferences for trail attributes, supply gaps in trail networks, and their barriers to participating in physical activity/recreation.

INTRODUCTION

The US Centers for Disease Control and Prevention (CDC), among many others, are concerned about dramatic increases in rates of physical inactivity, overweight and obesity in the U.S. These health issues are of equal concern to citizens in Oregon. Overweight and obesity are associated with increases in several chronic diseases such as coronary heart disease, type 2 diabetes, and various cancers. Physical activity significantly mediates many chronic diseases, regardless of weight-class. Given the beneficial effects of physical activity in preventing several chronic diseases, reducing sedentary lifestyles is a focus of public health programs.

Prescriptions for physical activity levels changed over a decade ago. The CDC and the American College of Sports Medicine in 1995 changed the recommended dose of physical activity. As reflected by the US Surgeon General, recommended physical activity is an accumulation of at least 30 minutes of moderate physical activity or 20 minutes of vigorous physical activity most days of the week. Parks and other infrastructure (bikeways, sidewalks) provide opportunities to meet the recommended levels of physical activity through recreation.

This project tests the hypothesis that people in Oregon with ready access to outdoor recreation opportunities are healthier than people residing in areas without access to such resources. Information about the health-related benefits of outdoor recreation is useful to managers and policymakers who are increasingly challenged to both describe the benefits resulting from recreation projects and to allocate their scarce resources to providing high-quality recreation opportunities in addition to other public services.

THE HEALTH EFFECTS OF PHYSICAL ACTIVITY

The primary sources of information on the epidemiology of physical activity, overweight and obesity cited in this report are published summaries of the literature. These quantitative and qualitative summary articles provide indicators on scientific consensus to date, such as the effects of inactivity and obesity on morbidity and mortality (Blair and Brodney, 1999).

Overweight and obesity are associated with increased health risks for certain chronic diseases such as coronary heart disease, type 2 diabetes, various cancers (e.g., endometrial, breast, and colon cancers), among other diseases and disorders (Mokdad, et al. 2003). Figure 1 shows the percentages of healthy weight individuals (40% of adults) with chronic diseases are substantially lower than the percentages of overweight/obese individuals (60% of adults) with chronic diseases in Oregon.

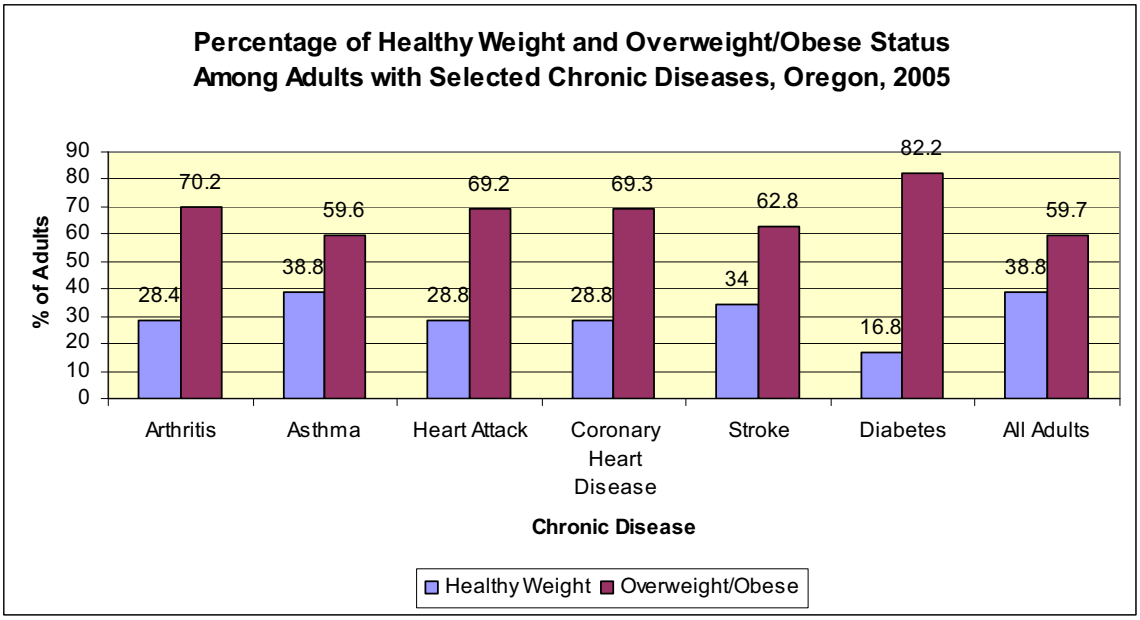

Figure 1. Chronic diseases among healthy weight and overweight/obese Oregonians. Source: ODHS, 2007.

Physical activity at recommended levels mitigates many health risks, regardless of weight class. As Blair and Brodney (1999) conclude:

1) Regular physical activity clearly attenuates many of the health risks associated with overweight and obesity;
2) Physical activity appears to not only attenuate the health risks of overweight and obesity, but active obese individuals have lower morbidity and mortality than normal weight individuals who are sedentary; and
3) Inactivity and low cardiorespiratory fitness are as important as overweight and obesity as mortality predictors.

Figure 2 shows physically active adults (56% of adults) have lower rates of many chronic diseases than sedentary adults (44% of adults) in Oregon. There is strong evidence of an inverse, linear relationship between physical activity and reductions in all-cause mortality, total cardiovascular and coronary heart disease incidence and mortality, type 2 diabetes mellitus, and colon cancer (Rankinen and Bouchard, 2002; Haennel and Lemire, 2002). The linear relationship suggests that as people move away from sedentarism, the health benefits of being physical active accumulate immediately, and continue to accrue as they become more physically active. For example, physical activity levels that expend 500 kcal/week (about 100 minutes/week) provide slight favorable effects, whereas expending 1000 kcal/week (about 200 minutes/week) in physical activity provides a 30% reduction in all-cause mortality rates (Rankinen and Bouchard, 2002). Landers (1997) and Fontaine (2000) discuss literature on mental/psychological benefits of physical activity and show that physical activity is associated with moderate reductions in depression (decreases symptoms similar to psychotherapy); small to moderate decrease in anxiety; small decrease in panic disorder; a large increase in energy & vigor; a small to moderate increase in self-esteem; and a small to moderate increase in positive

affect (especially if physical activity occurs in a social setting). Evidence on the relationship between physical activity and eating is unclear.

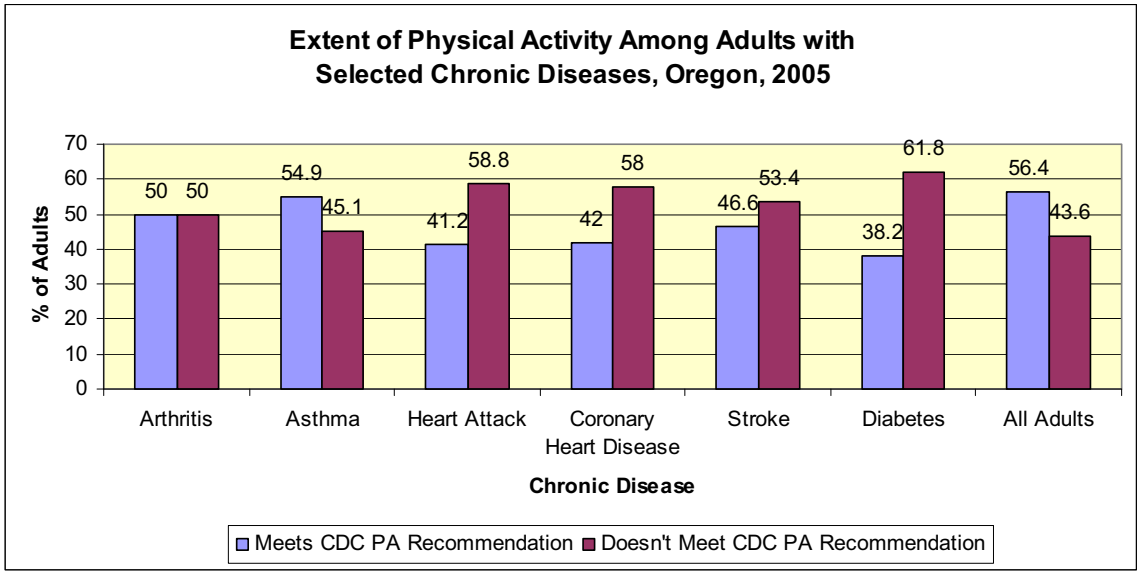

Figure 2. Extent of physical activity and chronic diseases in Oregon. Source: ODHS, 2007.

Also unclear is the relationship between physical activity and weight loss (Rankinen and Bouchard, 2002). Evidence suggests that physical inactivity is a strong contributing factor for overweight and obesity. Its effectiveness in promoting weight loss, however, is less than encouraging (Welk and Blair, 2000). As Wing (1999) concluded, exercising does not significantly increase initial weight loss over and above that obtained with diet only. Thus, a confusing message appears: physical activity helps prevent weight gain, but is ineffective at promoting weight loss. Overweight and obese individuals that initiate a physical activity program may become discouraged if they do not realize weight loss. Their loss, however, may not be in terms of body weight, but in the health risks associated with inactivity—overweight and obese individuals can gain the same health benefits (low chronic disease risks) as normal weight individuals from physical activity.

Physical activity messages that focus on behavioral changes (increased physical activity and healthy diets) rather than outcomes (weight loss) may provide the appropriate motivation for sedentary individuals (normal weight, overweight, or obese) to become physically active. Increasing the proportion of physically active individuals in society (regardless of weight) would greatly reduce the public health care burden (Welk and Blair, 2000). Maiback (2007), however, raises the issue whether the problem is inactive individuals, or whether it is inactive environments. The lack of places and social opportunities for physical activity may be equally to blame for the increasing rates of obesity and poor health in the US.

PHYSICAL ACTIVITY AND THE ENVIRONMENT

Leisure-time physical activity often connotes exercise. The Dictionary of Sport and Exercise Science operationally defines physical activity as "movement of the human body that results in the expenditure of energy at a level above the resting metabolic rate." Thus, physical activity can take place not only as deliberative exercise, but also at the workplace, in forms of transportation (walking, biking), in household activities, and in leisure-time, recreational activities.

Most epidemiological studies that link environmental factors with participation in physical activities have been conducted in urban environments that look at land use patterns, neighborhood designs, parks, and transportation infrastructure (sidewalks, bike lanes, trails). Humpel, Owen and Leslie (2002) and Williams (2007), after reviewing the literature, conclude that accessibility, opportunities, and aesthetic attributes have the strongest associations with physical activity. Weather and safety were found to have less-strong relationships with physical activity. Factors of accessibility that promoted physical activity included bike paths, local parks, density of facilities and shops within walking distance. Factors of accessibility that reduced physical activity included busy streets, steep hills, lack of or inadequate facilities and distance from residence to resources. Opportunities that were positively associated with physical activity included home exercise equipment, awareness of facilities, satisfaction with facilities, and local clubs. Lack of equipment was found to be negatively associated with physical activity. Aesthetic attributes that promote physical activity included friendliness of neighborhood, attractiveness of local area, and enjoyable scenery.

Sallis and Kerr (2006) summarize some of the findings from research on physical activity and the built environment. Access to parks and trails is consistently related to activity levels (Roux et al., 2007). The more distant recreation facilities are from an individual's residence, the less likely they are to use it. However, parks with more natural attributes associated with them have disproportionately larger volumes of use than other parks. As Giles-Corti et al. (2005) show, people are more likely to walk in parks when they are close, large, and have a variety of features. Parks and other public lands that provide recreational (and transportation) opportunities may promote health through physical activity. Users of public open space are three-times more likely to meet recommended physical activity levels (Giles-Corti et al., 2005). Gordon, Zizzi and Pauline (2004) found that 25% of respondents surveyed at a newly constructed rail trail in a rural city were sedentary prior to the trail's development. Habitually active rail trail users modestly increased their activity levels (0-26%), whereas new exercisers (i.e., previously sedentary) increased their activity levels 51-100%. Thus, parks and other areas to recreate help move people from sedentary-levels up the dose response function of health benefits from physical activity.

TRENDS IN PHYSICAL ACTIVITY, OVERWEIGHT, AND OBESITY

The US and Oregon

BRFSS data reported by the CDC is used to compare levels and trends in health prevalence measures between Oregon and the US. In 2001, the CDC changed their question relating to physical activity. From 1990 to 2002, primarily every other year, BRFSS respondents were asked if they had no leisure time physical activity. US leisure time physical inactivity was higher than Oregon's, with both falling over time. Oregon's rate of change was about 0.11% per year, while the US's proportion was falling twice as fast at about 0.22% per year. Figure 3 graphs the proportion of adults who reported meeting the CDC's minimum recommendation for physical activity from 2001 to 2005. Oregon's proportion of physical activity is higher than the US, with both trending upward. Oregon's increase in physical activity is about 0.9% per year, while for the US it is 0.75% per year. Figure 4 shows Oregon is fairing better than the US in proportion of adults physically active in 2005 (56.4% v. 49.1%, respectively).

Figure 5 graphs proportion and trends of overweight (BMI 25.0 to 29.9) for the US and Oregon. Proportions of overweight are erratic, possibly due to differences in samples from year-to-year and that BMI is self-reported. There is little difference between the US and Oregon, on average. In 2002, Oregon's and the US's proportion of overweight adults were nearly identical at 37% (Figure 6).

Figure 7 graphs proportion and trends of obesity (BMI >30) for the US and Oregon. Proportions and trends of obesity are similar between the US and Oregon. Figure 8 shows Oregon is doing a little better than the US in 2002 with a lower proportion of obesity than the US (20% v. 22%, respectively).

Appendix A displays trend graphs for physical activity, overweight and obesity by gender for the US and Oregon. Rates of physical activity for Oregonians are higher than the US regardless of gender. Rates of increase in physical activity are higher for females (Oregon: 1.12% per year; US: 1.18% per year) than males (Oregon: 0.65% per year; US: 0.25% per year). However, Oregon males' rate of increase is over twice as large per year as the US. Figure 4 shows that, in 2005, the proportion of females in Oregon that are physically active is disproportionately higher than physically active males when compared to the relative proportions for the US.

Overweight data for females in the US and Oregon are nearly identical in rates and trends. However, data for males is highly erratic, although males in Oregon appear to be doing better than the US (Oregon: 0.06% per year; US: 0.16% per year). Figure 6 shows the proportion of males that are overweight is 50% higher than the proportion of females that are overweight in the US and in Oregon in 2002, with overweight rates by gender being nearly identical between Oregon and the US (Females: 30%; Males: 44%).

Obesity data is fairly smooth for both females and males, with Oregon doing slightly worse than the US in trends. Figure 8 shows that the proportion of obese adults in Oregon is slightly lower than the national rate in 2002, with the proportion of males that are obese being disproportionately lower than females when compared to the relative proportions for the US.

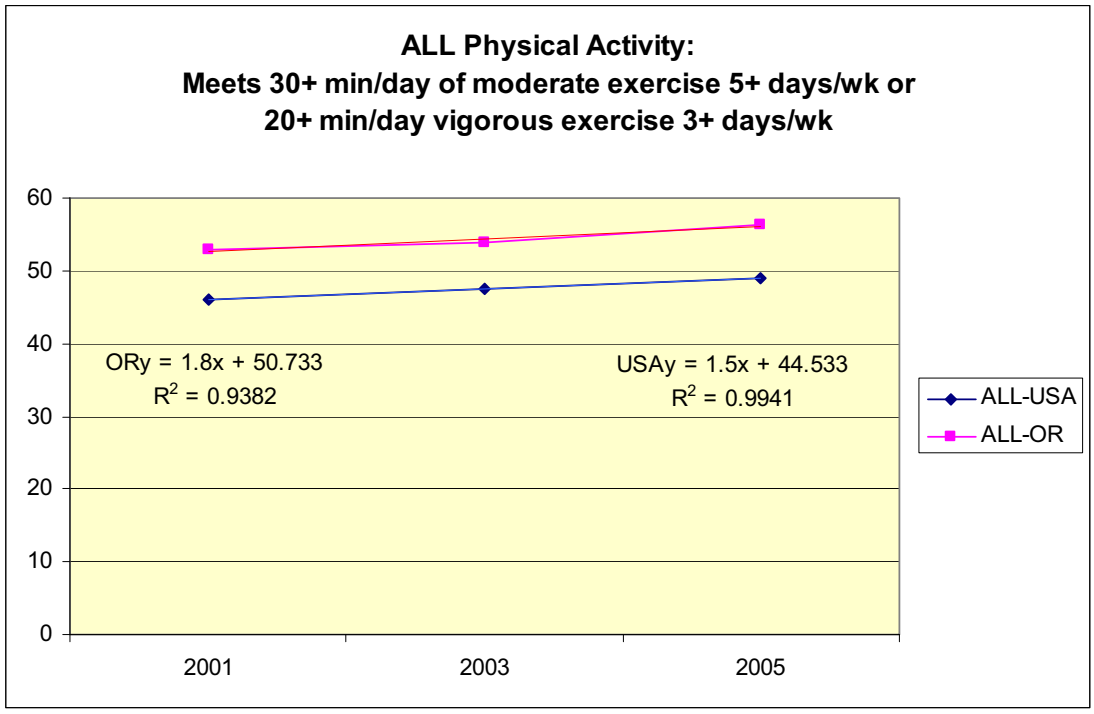

Figure 3. Trends in meeting CDC's minimum recommendation for physical activity—the US and Oregon. Source: BRFSS data.

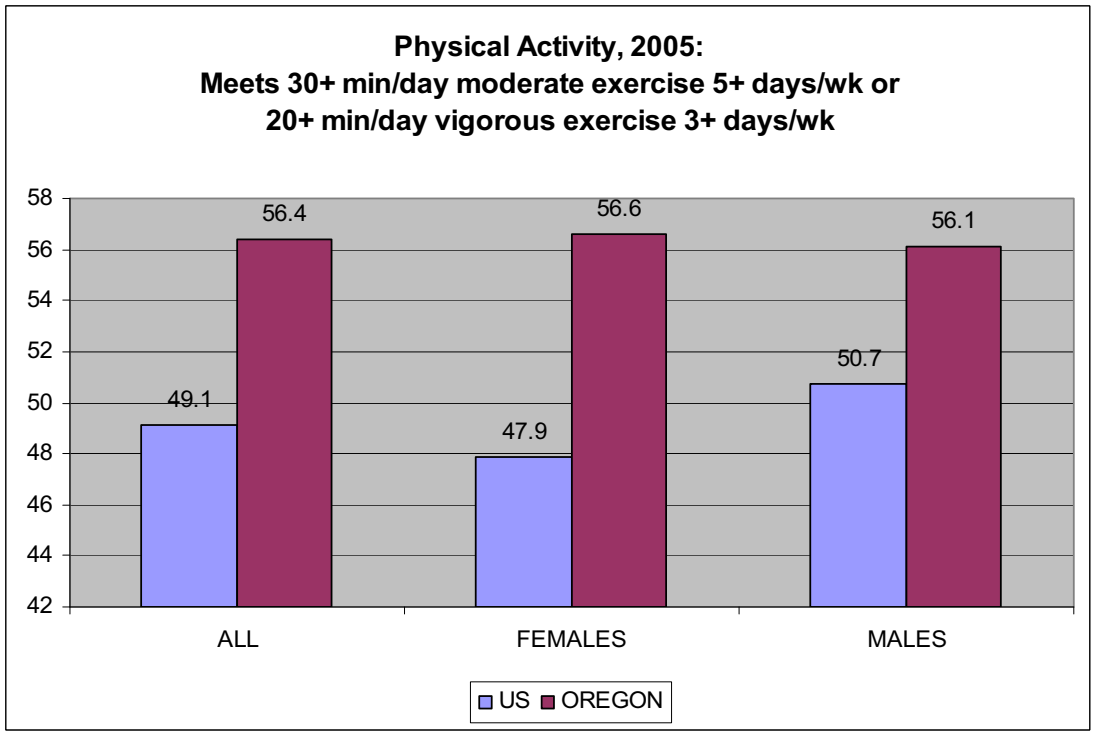

Figure 4. Physical activity proportion for US and Oregon in total and by gender, 2005. Source: BRFSS data.

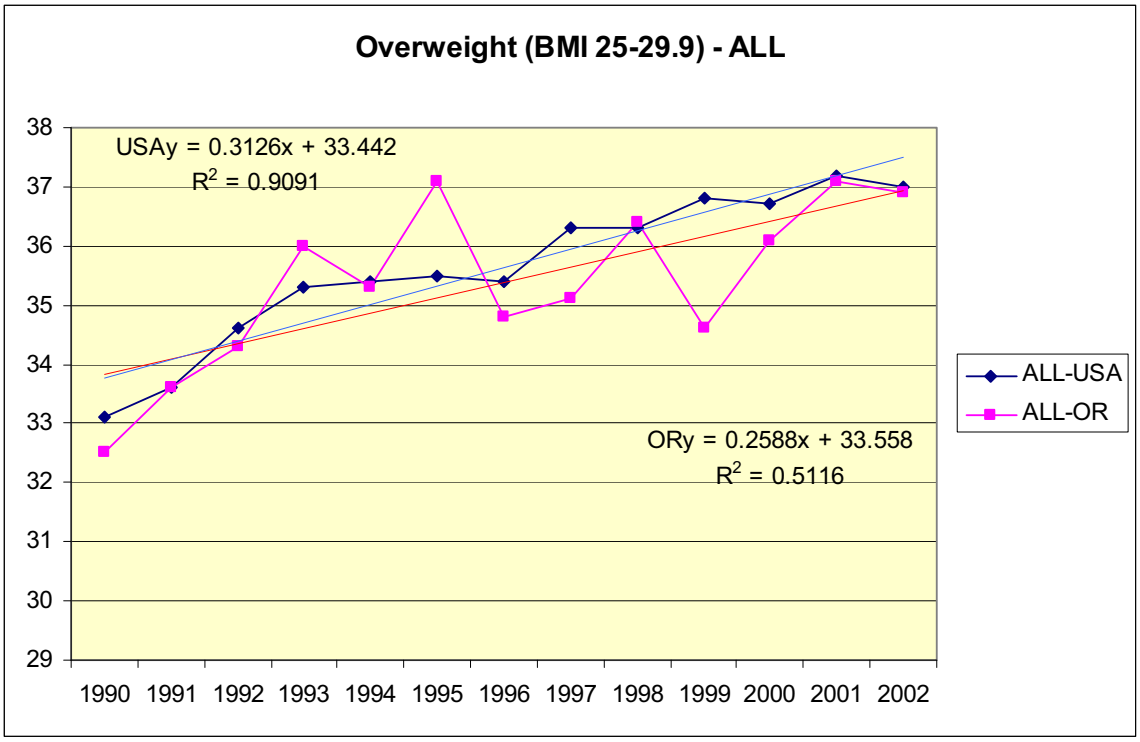

Figure 5. Trends in overweight for the US and Oregon. Source: BRFSS data.

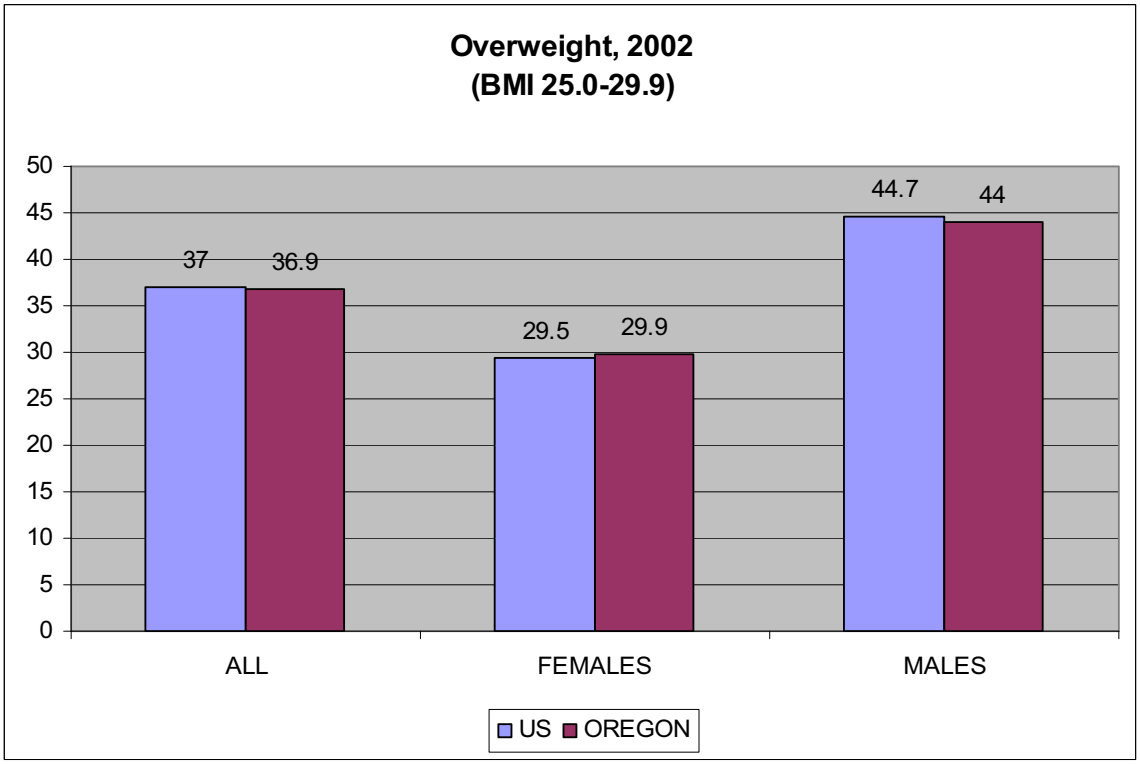

Figure 6. Overweight proportion in Oregon and the US in total and by gender, 2002. Source: BRFSS data.

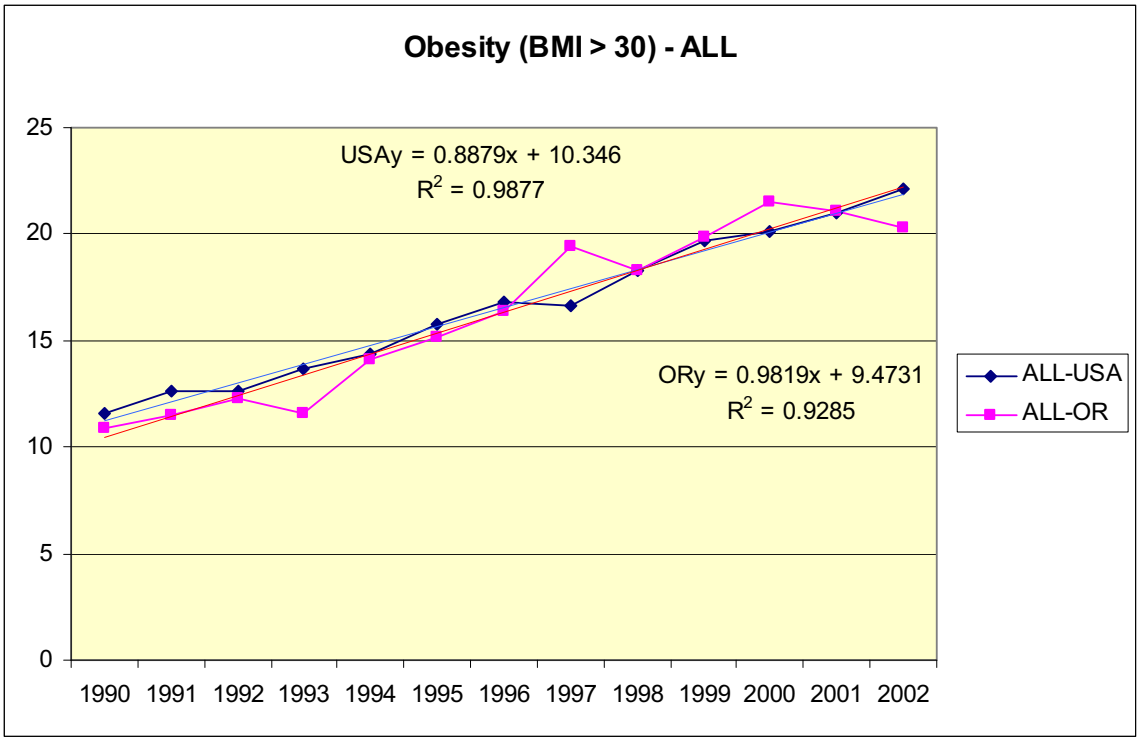

Figure 7. Trends in obesity for the US and Oregon. Source: BRFSS data.

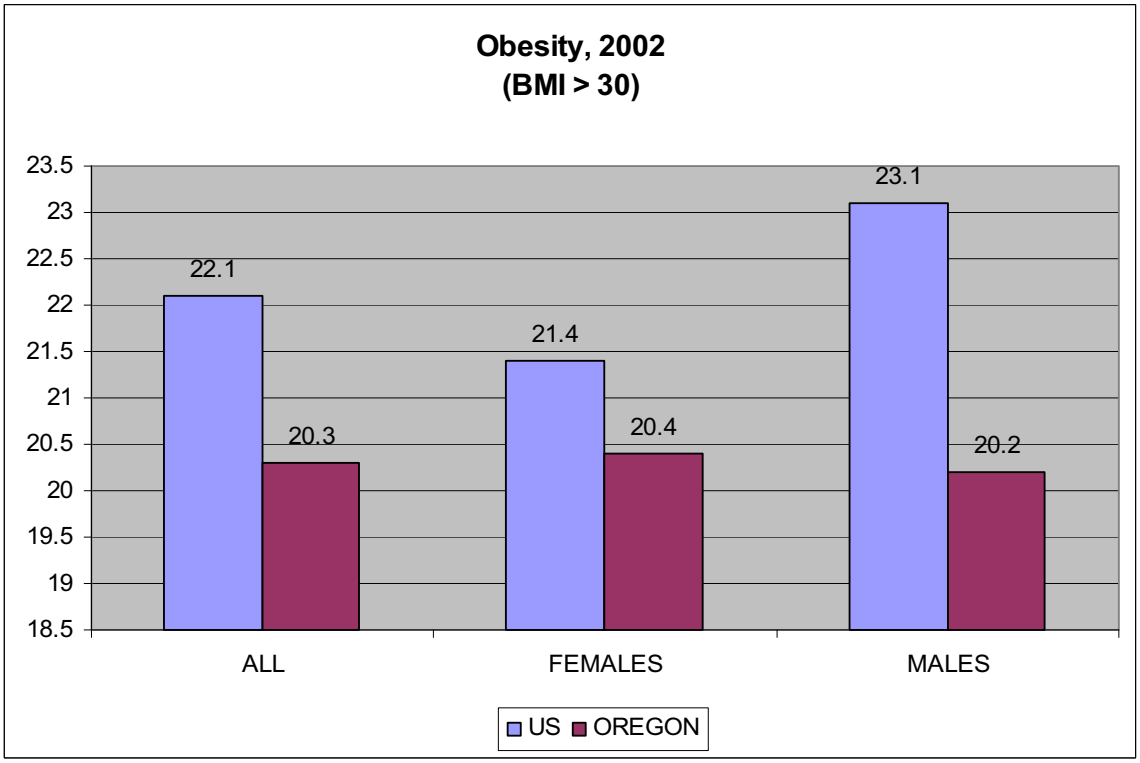

Figure 8. Obesity proportion for Oregon and the US in total and by gender, 2002. Source: BRFSS data.

Figure 9 shows the proportions of physical activity by age class for Oregon and the US in 2005. Oregon's proportions of physical activity exceed those for the US across all age classes, with a downward trend in physical activity. Appendix B provides trend graphs for physical activity, overweight and obesity by age class for the US and Oregon. Physical activity rates for 18-24 year olds in Oregon is growing four times faster than the US (1.6% per year v. 0.4% per year, respectively). Rates for 25-34 year olds in Oregon are growing twice as fast as the US (0.55% v. 0.25% per year, respectively). Oregon's 35-44 year olds have rates of physical activity increasing faster than the US's rates (1% per year v. 0.6% per year, respectively). However, Oregon's 45-54 year olds' rate of physical activity increase is lower than the US's rate (1% v. 1.25% per year, respectively). Oregon's 55-64 year olds are increasing their proportion of physically active adults faster than the US (0.75% v. 0.38% per year, respectively). Oregon's 65+ year olds are not increasing their proportion in physical activity as fast as the US (0.4% v. 0.7% per year, respectively).

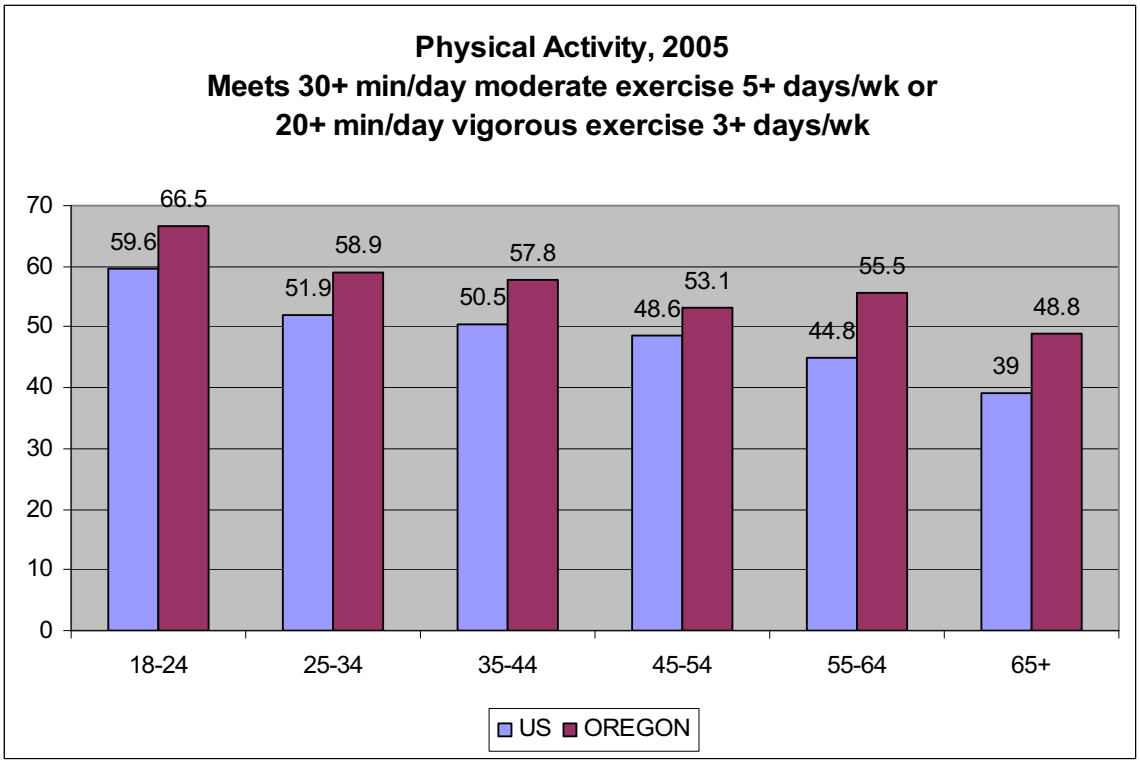

Figure 9. Physical activity proportion for Oregon and the US by age class, 2005. Source: BRFSS data.

Figure 10 shows proportion of overweight for Oregon and the US by age class. The proportions of adults that are overweight in Oregon and the US in 2002 were nearly identical and increasing with age. Appendix B shows 18-24 year olds and 65+ year olds have nearly identical rates of change in proportions of overweight adults for Oregon and the US, at about 0.35% per year increase in proportion of overweight individuals. Data for 35-49 year olds and 50-64 year olds are erratic, but the general trend seems to be about 0.22% per year for the US and Oregon (ignoring the outliers in Oregon's data, the beginning and ending points are the same as the US

and therefore the trend would be similar). Oregon's and the US's 50-64 year olds seem to have a decreasing trend in proportion of overweight (-0.21% v. -0.04% per year, respectively).

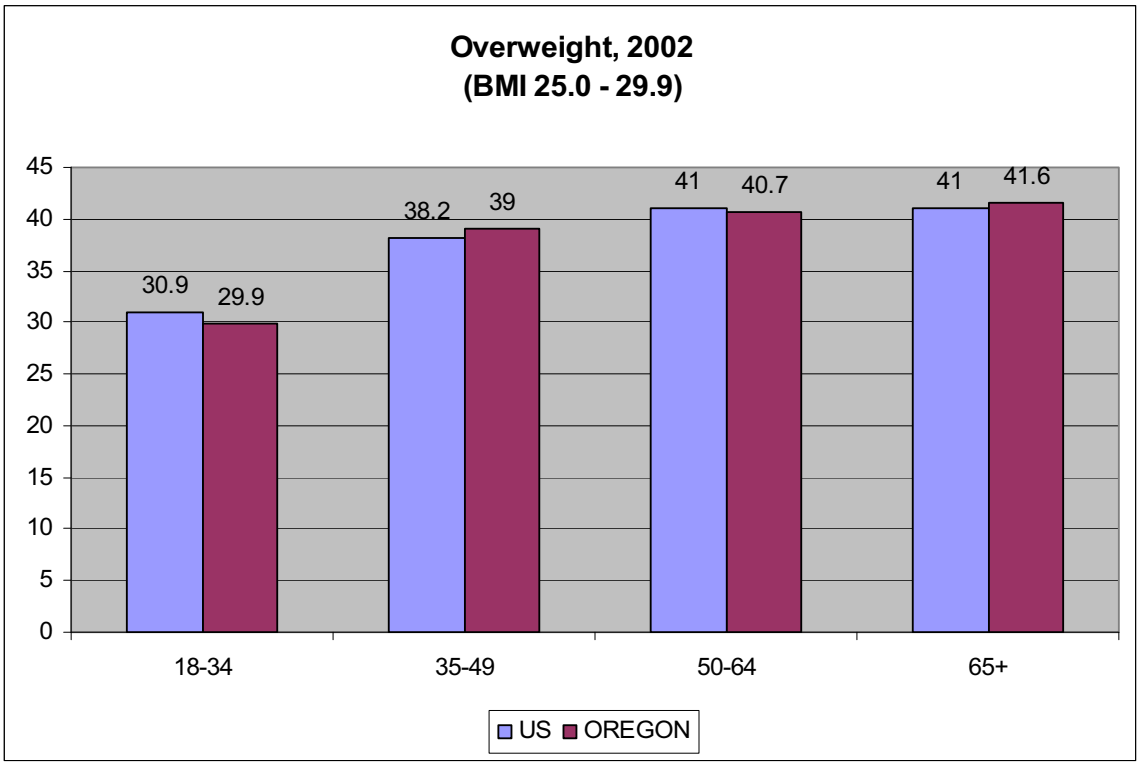

Figure 10. Overweight proportion for Oregon and the US by age class, 2002. Source: BRFSS data.

Figure 11 shows obesity proportions in 2002 are slightly lower for Oregon in all age classes except 50-64 year olds than the US; however, these differences are likely not significant. Appendix B shows rates of increase in obesity proportions are nearly identical between Oregon and the US, and are about 1% per year (18-34 years: 0.8%; 35-49 years: 0.9%; 50-64 years: 1.2%; and 65+: 0.7% per year for Oregon—national trends are slightly lower than Oregon).

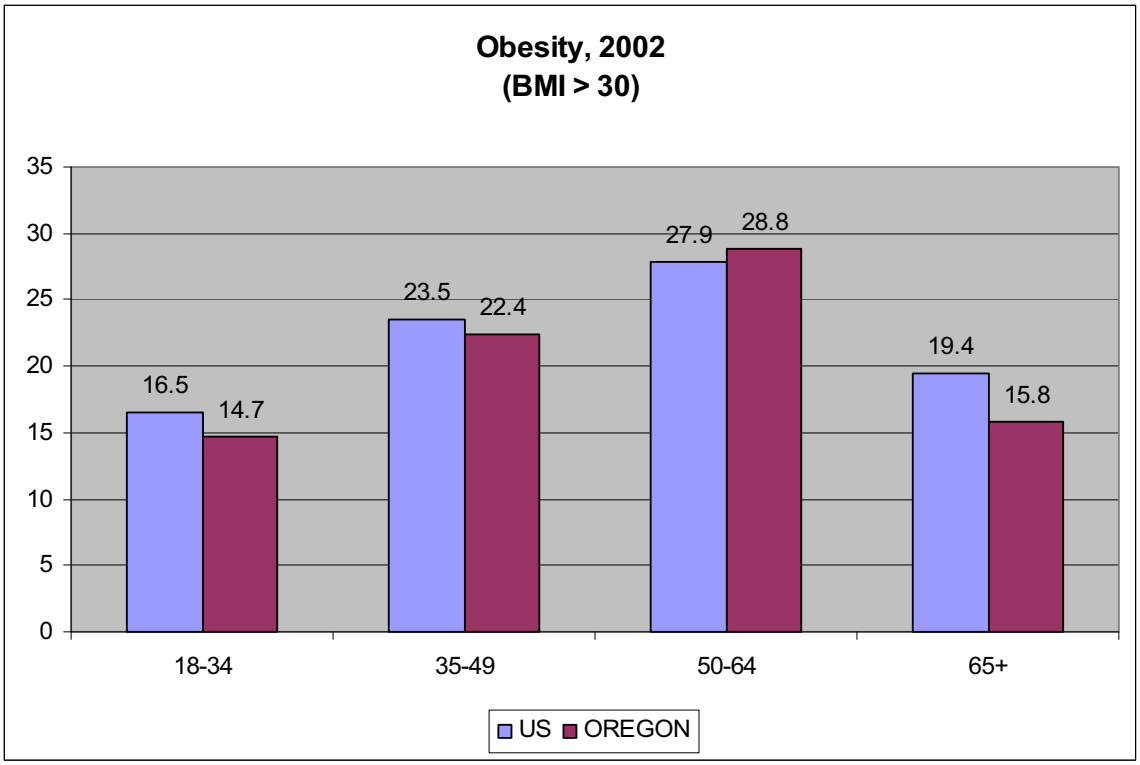

Figure 11. Obesity proportion for Oregon and the US by age class, 2002. Source: BRFSS data.

Oregon Counties

Proportions of physical activity, overweight and obesity are provided by Oregon county, along with rates of change between 2001 and 2005. These rates of change may not be indicative of the long-term trends in any specific county due to the limited number of data points, inherent sampling issues in the BRFSS survey, and/or changing demographics within each county. Appendix C provides tabular data by county and graphs of trends in proportions of physical activity, overweight, obesity and consumption of fruits and vegetables between 2001 and 2005. We will only identify the top five and bottom five counties in each category in the text, referring the reader to the tables and figures in Appendix C for data on other counties.

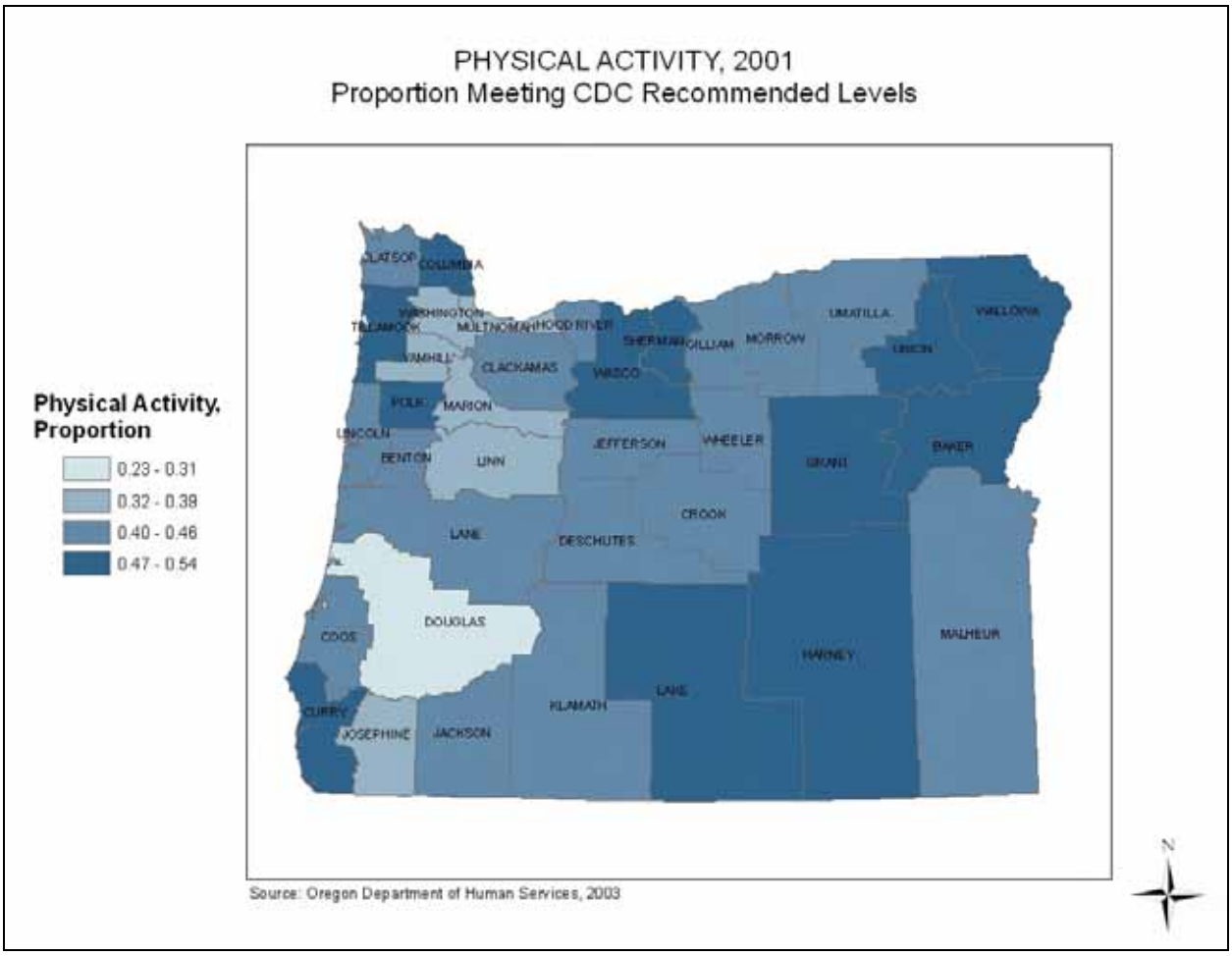

Figure 12. Proportion of physical activity by Oregon counties, 2001.

Figure 12 displays proportions of physical activity by county in 2001 and Figure 13 displays data for 2005. In 2001, the average proportion for physical activity was 44%, ranging from 23% to 54%. The five counties with the highest proportions of physical activity in 2001 included Columbia, Harney and Polk (52%), Baker (53%), and Sherman/Wasco (54%). Counties with the lowest proportion of physical activity included Douglas (23%), Yamhill (31%), Linn and Marion (35%), and Josephine, Multnomah and Washington (37%).

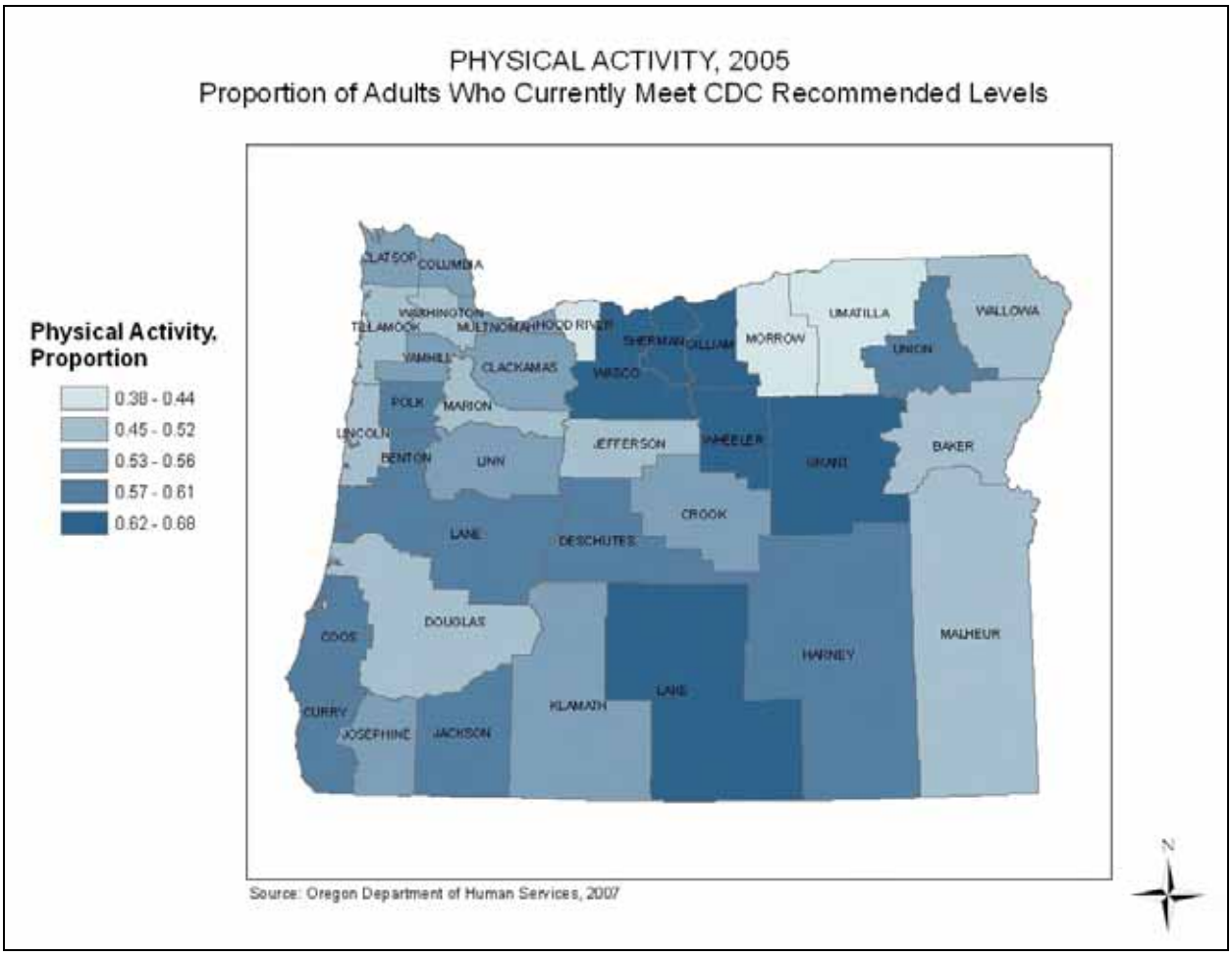

Figure 13. Proportion of physical activity by Oregon counties, 2005.

In 2005, the average proportion for physical activity was 55%, ranging from 38% to 68%. The five counties with the highest proportions of physical activity in 2005 were Union (61%), Lake and Sherman/Wasco (63%), Gilliam/Wheeler (65%), and Grant (68%). Counties with the lowest proportion of physical activity included Umatilla (38%), Morrow (40%), Hood River (44%), and Malhuer and Baker (47%).

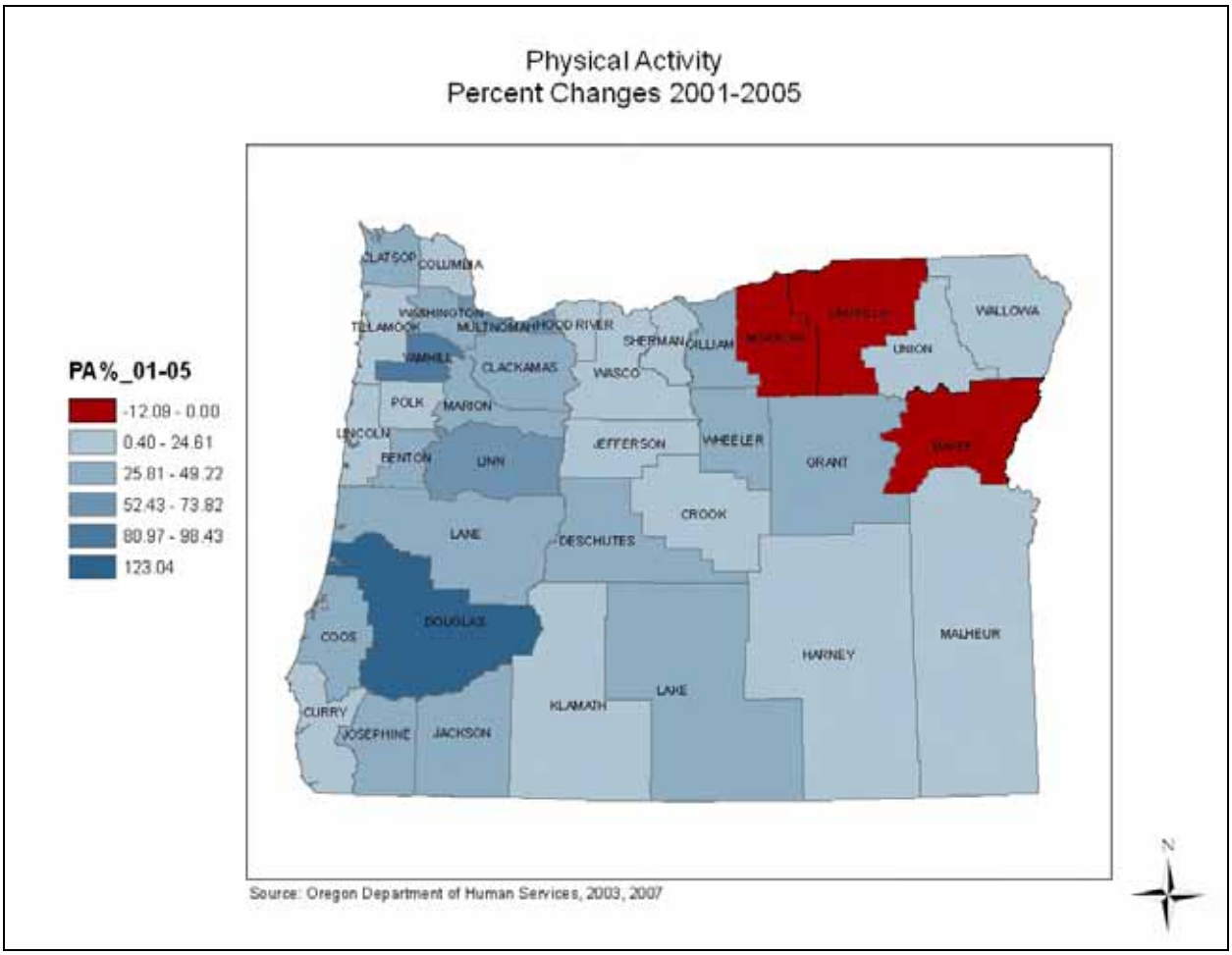

Figure 14. Rates of change in physical activity proportions by Oregon counties, 2001-2005.

Figure 14 shows the rates of change in proportions for physical activity between 2001 and 2005 by Oregon county. The average rate of change for physical activity was 27%, ranging from -12% to 123%. Umatilla (-12%), Baker (-11%), Morrow (-8%) had decreasing proportions of physical activity from 2001-2005, while Tillamook's (0%) proportion remained unchanged. Josephine (46%), Multnomah (52%), Linn (55%), Yamhill (81%) and Douglas (123%) had the largest increase in physical activity proportions.

Counties may be labeled as at-risk due to relatively low physical activity participation rates. Counties that have been identified as "in need" based on adult physical activity rates and trends projected by the Population Research Center, Portland State University for Oregon Parks and Recreation Department. These counties include Baker, Columbia, Crook, Douglas, Harney, Hood River, Josephine, Morrow, Tillamook Umatilla and Wallowa and are supported with data provided in this report.

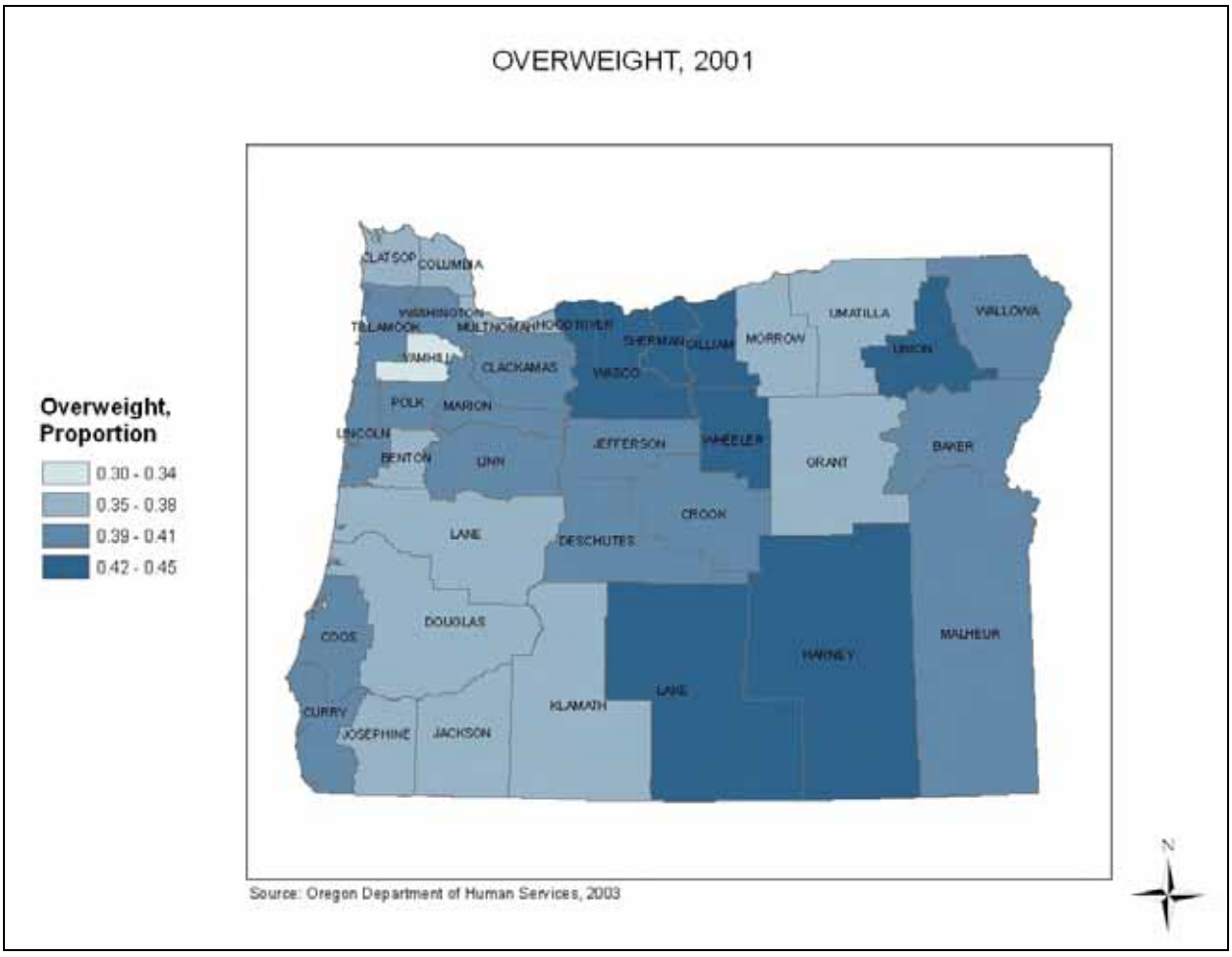

Figure 15. Proportion of overweight by Oregon counties, 2001.

Figure 15 displays proportions of overweight by county in 2001 and Figure 16 displays data for 2005. In 2001, the average proportion for overweight was 39%, ranging from 30% to 45%. The five counties with the highest proportions of overweight in 2001 included Lake, Union and Hood River (42%), Harney and Gilliam/Wheeler (43%), and Sherman/Wasco (45%). Counties with the lowest proportion of overweight included Yamhill (30%), and Klamath, Columbia, Multnomah, Jackson and Benton (35%).

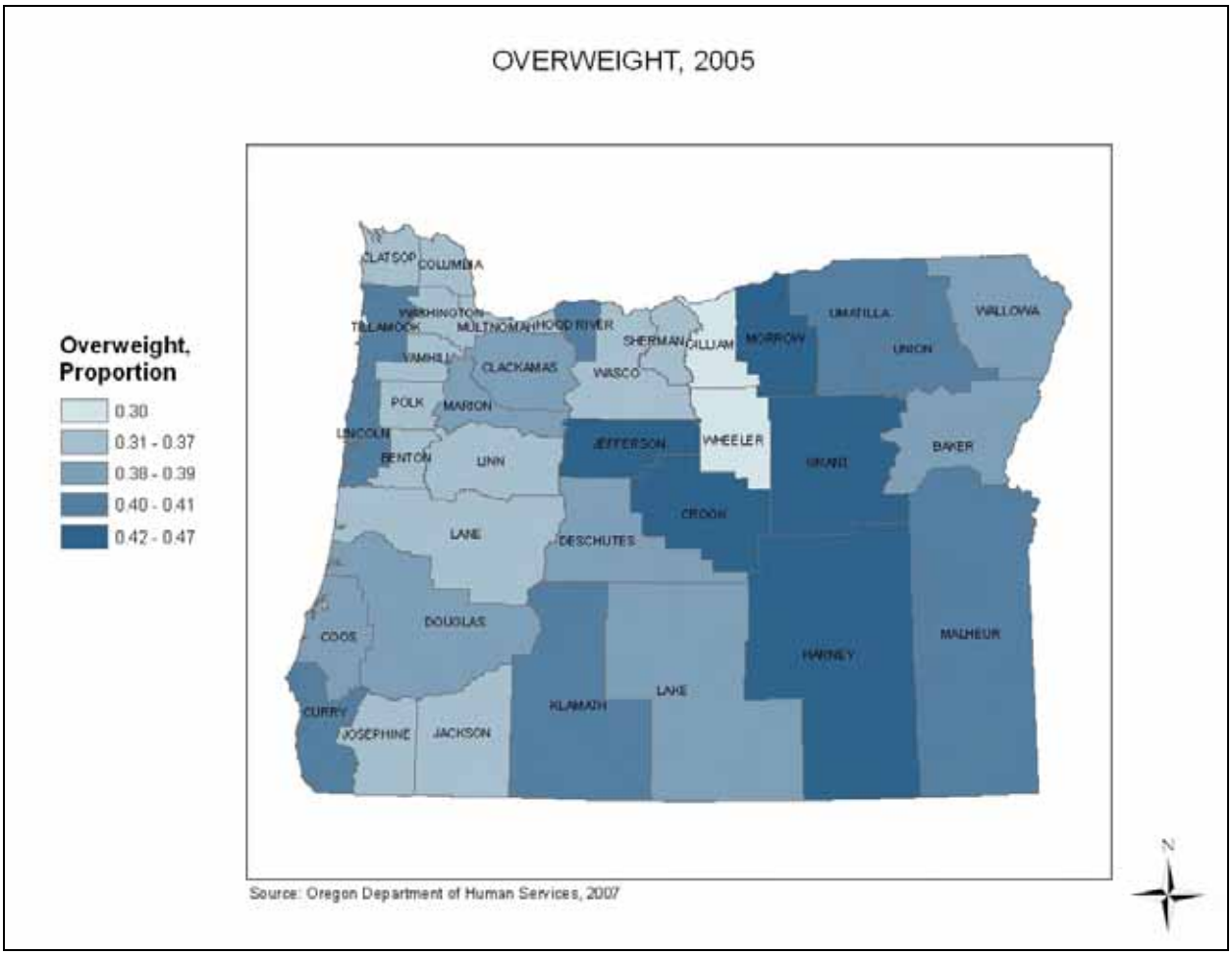

Figure 16. Proportion of overweight by Oregon counties, 2005.

In 2005, the average proportion for overweight was 38%, ranging from 30% to 47%. The five counties with the highest proportions of overweight in 2005 included Jefferson (43%), Crook and Grant (45%), Morrow (46%), and Harney (47%). Counties with the lowest proportion of overweight included Gilliam/Wheeler (30%), Clatsop and Multnomah (34%), and Josephine and Linn (35%).

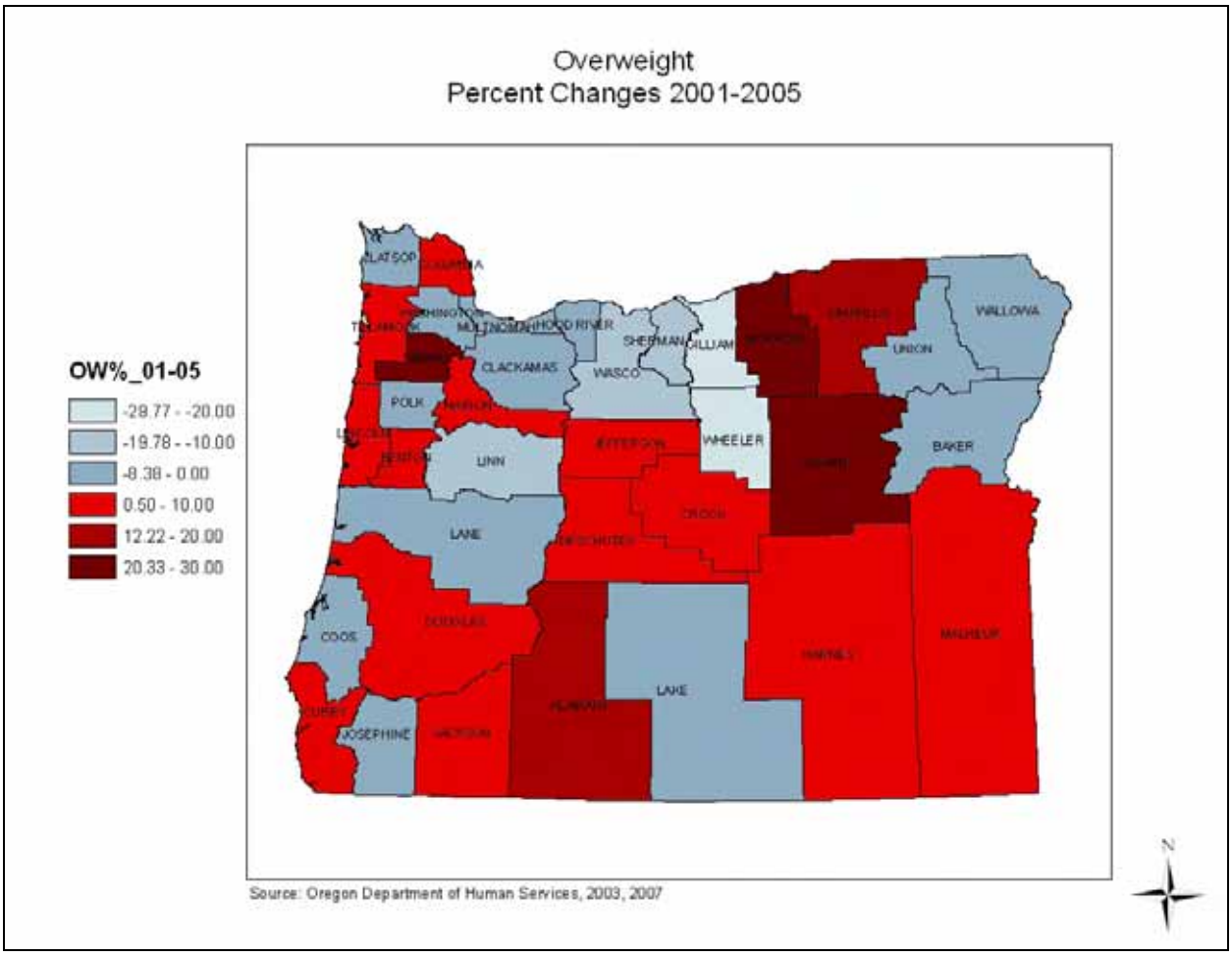

Figure 17. Rates of change in overweight proportions by Oregon counties, 2001-2005.

Figure 17 shows the rates of change in proportions for overweight between 2001 and 2005 by Oregon county. The average rate of change for overweight was -1%, ranging from -30% to 25%. The counties with the highest increases in overweight included Umatilla (12%), Klamath (13%), Yamhill (20%), Grant (23%), and Morrow (25%). Counties with the largest decreases in proportions of overweight included Gilliam/Wheeler (-30%), Sherman/Wasco (-20%), Linn (-12%), Clatsop (-8%), and Lake (-7%).

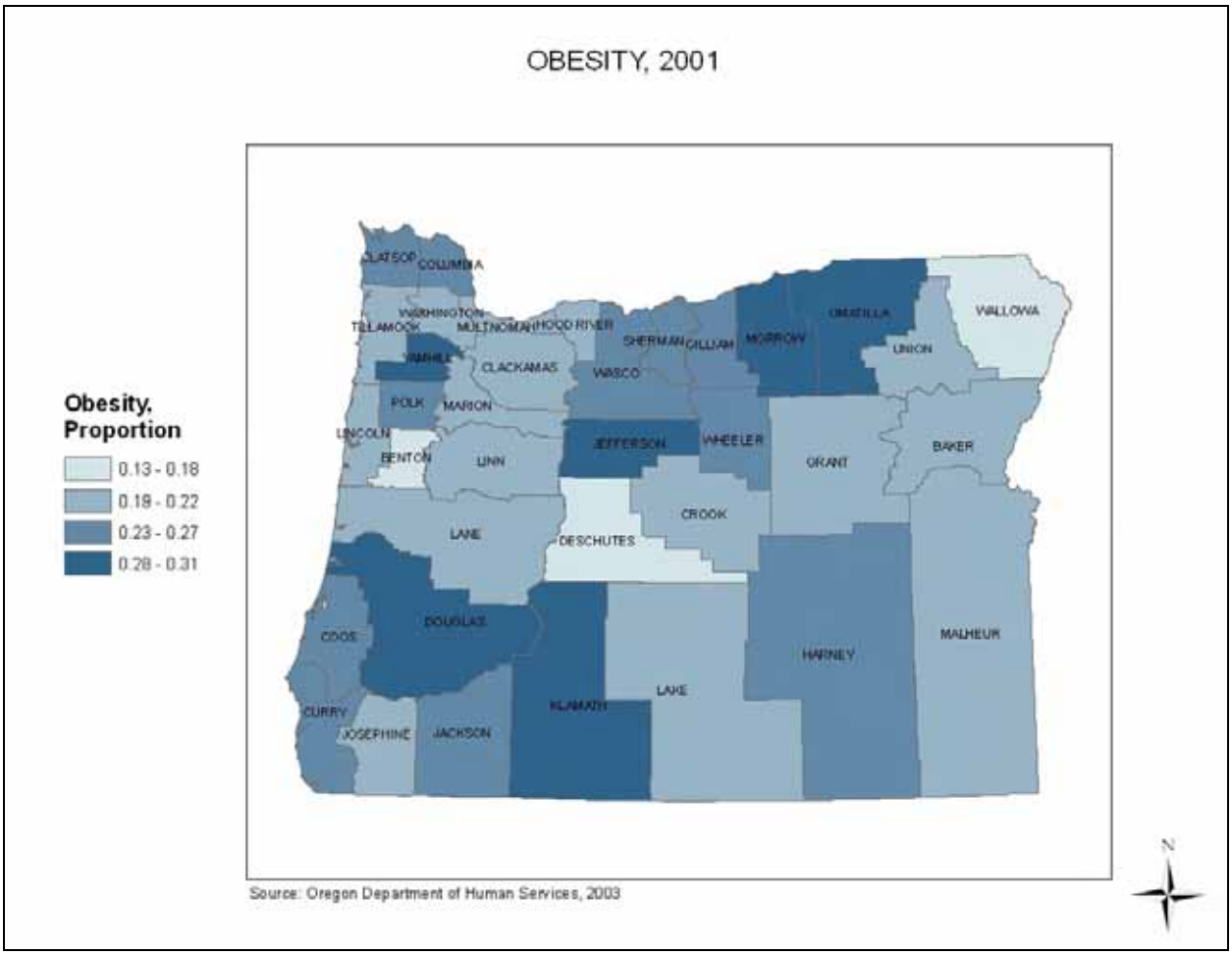

Figure 18. Proportion of obesity by Oregon counties, 2001.

Figure 18 displays proportions of obese by county in 2001 and Figure 19 displays data for 2005. In 2001, the average proportion for obese was 22%, ranging from 13% to 31%. The five counties with the highest proportions of obese in 2001 include Yamhill and Umatilla (27%), Douglas and Klamath (28%), Jefferson (30%), and Morrow (31%). Counties with the lowest proportion of obese included Deschutes (13%), Benton (14%), Wallowa (17%), and Clackamas and Grant (18%).

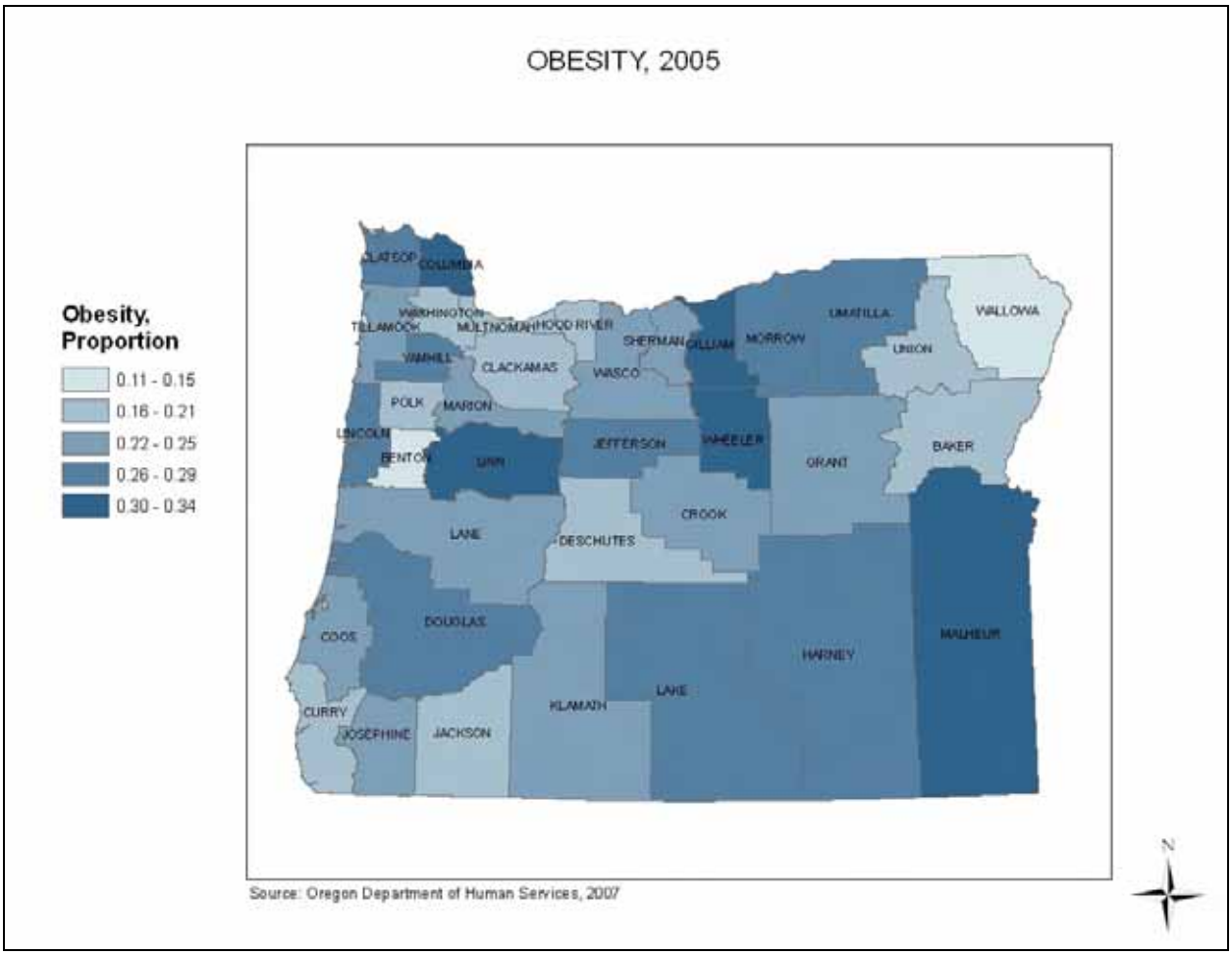

Figure 19. Proportion of obesity by Oregon counties, 2005.

In 2005, the average proportion for obese was 24%, ranging from 11% to 34%. The five counties with the highest proportions of obese in 2005 included Jefferson and Morrow (29%), Malhuer (30%), Linn and Columbia (31%), and Gilliam/Wheeler (34%). Counties with the lowest proportion of obese included Wallowa (11%), Benton (15%), Curry (17%), Deschutes (18%), and Baker and Multnomah (19%).

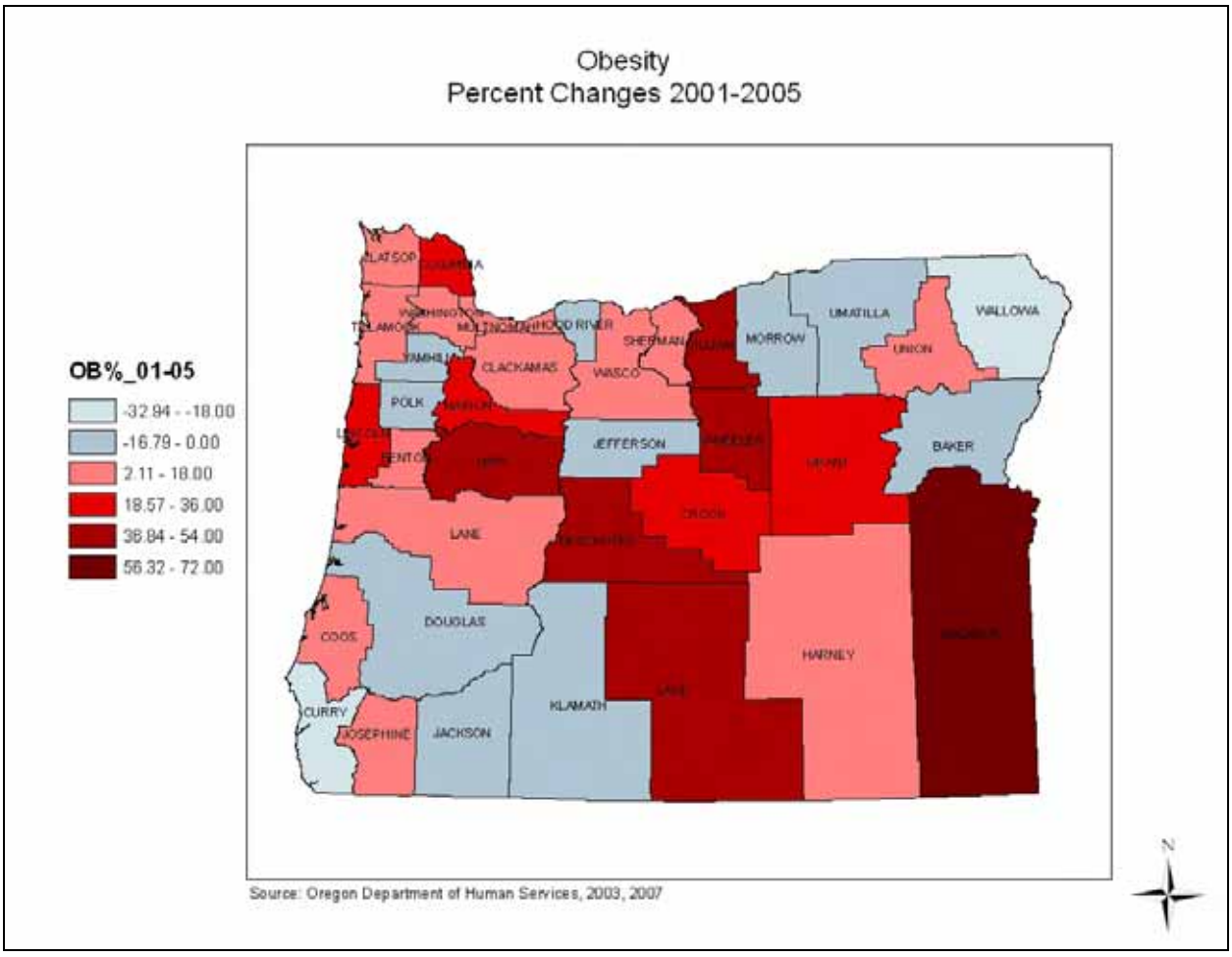

Figure 20. Rates of change in obesity proportions by Oregon counties, 2001-2005.

Figure 20 shows the rates of change in proportions for obese between 2001 and 2005 by Oregon county. The average rate of change for obesity was 10%, ranging from -33% to 56%. The counties with the highest increases in obesity included Lake (37%), Gilliam/Wheeler (40%), Deschutes (42%), Linn (46%), and Malhuer (56%). Counties with the largest decreases in proportions of obesity included Wallowa (-33%), Curry (-28%), Klamath (-17%), Polk (-13%), and Jackson (-12%).

LINKAGES BETWEEN PHYSICAL ACTIVITY, OVERWEIGHT, OBESITY AND RECREATION SUPPLY IN OREGON

Proportion of physical activity, overweight and obesity vary across counties in Oregon. The supply of recreation opportunities likewise vary. This section measures the association among physical activity, overweight, obesity and recreation supply while holding other potential confounding factors constant.

Conceptually, our model is measuring the direct effect of natural areas/recreation supply on physical activity and weight status, while controlling for the indirect relationships, or dependence, of physical activity on weight status (. There are many other factors associated with overall health and weight, including dietary habits, neighborhood design, social/cultural influences, among other factors (Wells et al., 2007), that are not accounted for in our model. Instead, we are interested in isolating the relationship between recreation supply and demand and health indicators.

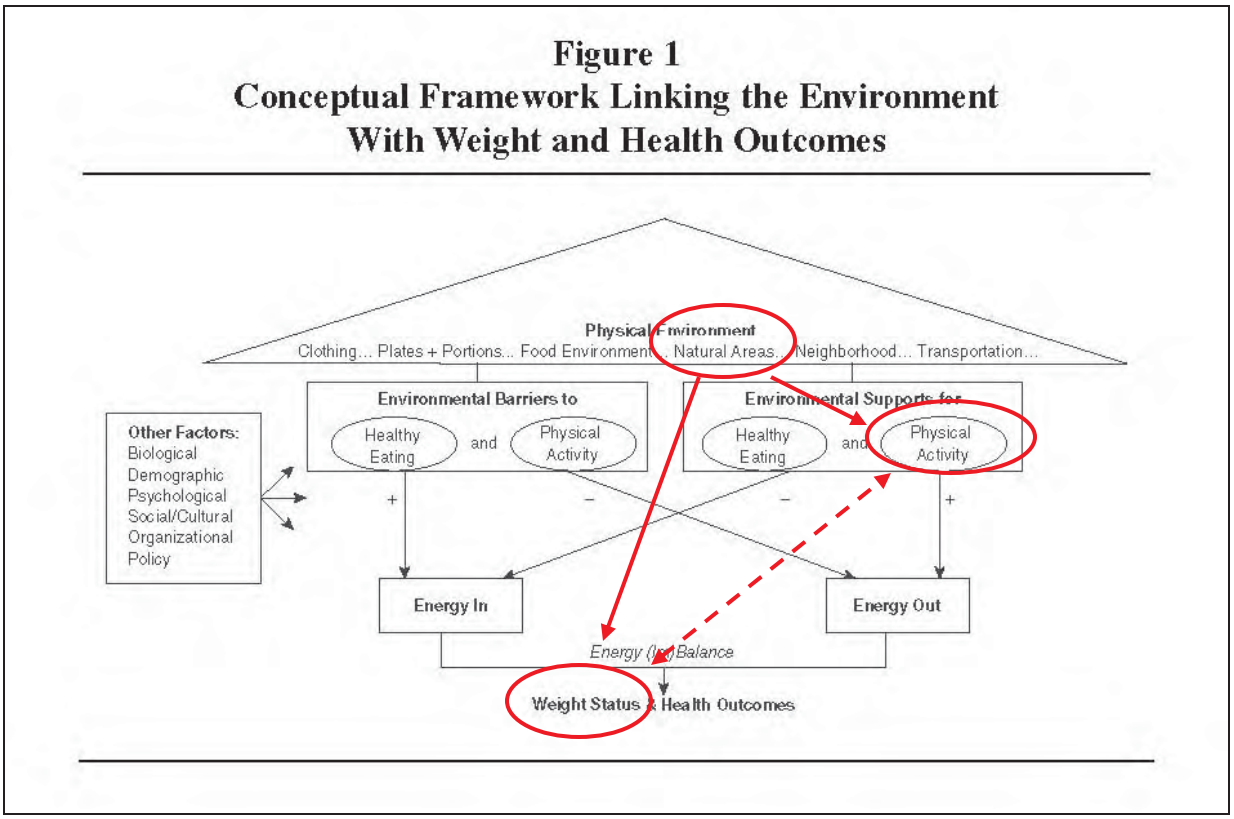

Figure 21. Focus on direct effect of natural areas on physical activity and weight status. Source: Wells et al. (2007).

Data

This analysis is conducted with data collected in the 2000-2001 period. We are restricted to this period due to data availability: 2000 US Census data, 2001 SCORP inventory data (OPRD, 2001), and the 2002 SCORP participation survey (OPRD, 2003). Table 1 provides descriptions of variables and sources of data used in this analysis. Appendix D provides pairwise correlation

tests for health prevalence indicators, county classifications, and recreation supply measures, which contain a broader list of variables tested in this analysis. Appendix Table D1 shows health prevalence data are not strongly correlated with the majority of the demographic, county profile and recreation supply and demand variables in pairwise correlation tests. Appendix Table D2 shows that METRO, HHAC (household density per acre), and RURAL are highly correlated with several demographic characteristics of counties, such as age and age distribution, income levels, housing values, and racial profiles. Therefore, METRO, HHAC and RURAL will serve as proxies for demographic profiles of counties. Appendix Table D3 shows the volume of recreation supply measures, in miles and number of facilities, are correlated with metropolitan classification, household density, and public land ownership patterns. These recreation supply measures have been normalized by household density as number of miles per household.

Table 1. Variable descriptions and sources of data.

Variable	Description	Source
PA	Physical Activity, proportion of adults meeting CDC requirements, 2000-2001	Oregon Dept of Human Services, 2003
OW	Overweight (BMI 25.0-29.9), proportion of adults, 2000-2001	Oregon Dept of Human Services, 2003
OB	Obesity (BMI≥30.0), proportion of adults, 2000-2001	Oregon Dept of Human Services, 2003
HIKTRL	Hiking Trails, miles, 2001	OR SCORP Inventory, 2001
HIKTRLHH	Hiking Trail miles per household, 2001	Calculated from OR SCORP Inventory, 2001
URBTRL	Urban Trails, miles (bike, walking and jogging trails), 2001	OR SCORP Inventory, 2001
URBTRLHH	Urban Trail miles per household, 2001	Calculated from OR SCORP Inventory, 2001
PUBAC	Density of public lands (per acre), 1997	USDA NRCS, Natural Resources Inventory
TRAILP	Proportion of adults participating in Trail or Off-Trail Activities (hiking, mountain biking, cross-country skiing, etc.), 2002	OR SCORP Phone Survey 2002
ROADP	Proportion of adults participating in Road & Street Activities (walking, jogging, skating, skateboarding, etc), 2002	OR SCORP Phone Survey 2002
SPORTSP	Proportion of adults participating in Outdoor Sports & Games (soccer, football, golf, basketball, tennis, etc), 2002	OR SCORP Phone Survey 2002
TRAILD	Annual days per household participating in Trail & Off-Trail Activities, 2002	Calculated from OR SCORP Phone Survey 2002
ROADD	Annual days per household participating in Road & Street Activities, 2002	Calculated from OR SCORP Phone Survey 2002
SPORTSD	Annual days per household participating in Outdoor Sports & Games, 2002	Calculated from OR SCORP Phone Survey 2002
HHAC	Density of households (per acre), 2000	Calculated from US Census
COLLEGE	College, % 25+ years old with bachelor's degree, 2000	US Census
COMMUTE	Mean travel time to work (minutes), workers aged 16+, 2000	US Census
METRO	Metropolitan Status (0, 1), 2003	USDA Economic Research Service
RURAL	Rural Status (0,1), 2003	USDA Economic Research Service

Models

We model the dependence of rates of physical activity (PA), overweight (OW), and obesity (OB) on each other, measures of recreation supply (RS), and recreation participation (RP), while holding demographic characteristics (SD) constant (Figure 21):

$$PA = f(OW, OB, RS, RP, SD)$$
$$OW = f(PA, OB, RS, RP, SD)$$
$$OB = f(PA, OW, RS, RP, SD).$$

Cyclically, physical activity may affect overweight and obesity; overweight may affect physical activity and obesity; and obesity may affect physical activity and overweight. Thus, physical activity, overweight and obesity may be simultaneously determined in the equations above. Not accounting for simultaneity in the regressors leads to inconsistent and biased Ordinary Least Squares estimators. Simultaneity arises when a regressor is endogenous to the system and is, therefore, likely correlated with the error term. If simultaneity is present, then an alternative estimator, such as Two-Stage Least Squares, is required. Simultaneity and endogeneity tests (Appendix E) show that overweight and obesity are exogenous to physical activity; physical activity and obesity are exogenous to overweight; and overweight is exogenous to obesity. Only physical activity was found to be endogenous to obesity, possibly as a preventive measure and not for weight loss. Therefore, given overweight and obesity are exogenously determined we do not need to model the data as simultaneously determined and may proceed with Ordinary Least Squares.

Another statistical issue that should be addressed is the inherent spatial dependence of many types of data (Rosenberger et al., 2005). The data used in this analysis contain spatial aspects based on the arbitrary delineation of the spatial units (county boundaries), the spatial distribution of the supply of recreation opportunities, and the inherent mobility of county residents to seek out recreation opportunities beyond their county boundaries. However, as noted earlier, distance from residence is an important predictor of use of recreational resources. The majority of people use resources closer to home. All equations were tested for spatial dependence as lagged independent variables and as spatial error (Appendix F). Spatial dependence was rejected for the physical activity and overweight equations, but was accepted as spatial dependence in the error term in the obesity equation. The physical activity and overweight models are corrected for heteroskedasticity, while the obesity equation is corrected for heteroskedasticity via the spatial error component. Therefore, the final models estimated are:

$$PA = \beta_0 + \beta_1 OW + \beta_2 OB + \beta_3 HIKTRLHH + \beta_4 URBTRLHH + \beta_5 PUBAC + \beta_6 TRAILD + \beta_7 ROADD + \beta_8 SPORTSD + \beta_9 HHAC + \mu$$

$$OW = \beta_0 + \beta_1 PA + \beta_2 OB + \beta_3 HIKTRLHH + \beta_4 URBTRLHH + \beta_5 TRAILD + \beta_6 ROADD + \beta_7 SPORTSD + \beta_8 METRO + \beta_9 RURAL + \mu$$

$$OB = \beta_0 + \beta_1 PA + \beta_2 OW + \beta_3 HIKTRLHH + \beta_4 URBTRLHH + \beta_5 TRAILD + \beta_6 ROADD + \beta_7 SPORTSD + \beta_8 HHAC + \beta_9 COLLEGE + \beta_{10} COMMUTE + \mu \qquad \mu = \lambda\mu_{-1} + \varepsilon$$

Results

Table 2 provides summary statistics for variables used in this analysis along with measures for participation in recreation activities and number of recreation facilities. Maps showing the distribution of the recreation supply and demand variables across Oregon are provided in Appendix G. Based on the 2001 SCORP Inventory (OPRD, 2001), there was an average of 270 miles of hiking trails per county, ranging from 0 miles to 1,150 miles. Figure G1 shows the distribution of reported hiking trail miles, with higher miles clustered around Lane County and Wallowa County. Low miles were reported in the northwest and southeast portions of the state. Urban trail (biking, walking and jogging trails) miles averaged 106 miles per county, although there is likely double-counting for multi-purpose trails. They ranged from a reported 0 miles to 474 miles. Figure G2 shows the distribution of reported urban trail miles, with higher miles in the mid-valley region and low numbers in the eastern and northwestern portions of the state. We also used SCORP Inventory data to estimate the number of recreation facilities, which averaged 263 per county. These facilities included the number of baseball/softball fields; football/rugby/soccer fields; indoor and outdoor swimming pools; outdoor basketball nets; outdoor tennis courts; public and private golf courses; miscellaneous recreation centers; and baseball batting cages. Figure G3 shows the distribution of reported recreation facilities, with higher populated counties reporting more facilities and lower populated counties reporting fewer facilities.

The total estimated miles of trails and numbers of facilities are correlated with the number of households (Appendix D, Table D3). Therefore, we normalize the recreation supply data by converting them to per household measures. Figure G4 shows the distribution of household density (per acre) across the state. Higher densities are centered on counties with metropolitan and urban centers. Hiking trail miles density averaged 0.03 miles per household, ranging from 0 to 0.3 miles per household. Figure G5 shows a more even distribution of these data across household density differences. Urban trail miles density averaged 0.01 miles per household, ranging from 0 to 0.08. Figure G6 shows how the distribution of these data is more evenly represented when accounting for population differences. Recreation facilities density averaged 0.01 facilities per household, ranging from 0 to 0.03. The normalized facility data were ultimately dropped from the estimated models because they remained highly correlated with metro and household density measures.

Recreation demand measures were derived from the 2002 SCORP participation survey (OPRD, 2003). An average of 49% of adults participated in trail or off-trail activities, including hiking, backpacking, mountain biking, cross-country skiing, orienteering, or horseback riding. Trail participation ranged from 34% to 65%, with no general visual patterns observable in the data (Figure G8). The average number of days of participating in trail or off-trail activities per year was about 6 days. Annual days in trail activities ranged from 3 to 12 days. Figure G9 shows higher days per household in the central and southeast portions of the state with the exception of Crook County (low rate), and Benton and Clatsop Counties (high rate). An average of 73% participated in road or street activities, including running or walking for exercise, walking for pleasure, in-line skating, or skateboarding. Road and street activity participation ranged from 53% to 92%, with higher rates clustered in the northwest portion of the state (Figure G10). The average number of days of participating in road or street activities per year was about 31 days, ranging from 22 to 45 days. These data were scattered across the state with no discernible

pattern (Figure G11). An average of 47% participated in outdoor sports and games, including golf, baseball, softball, football, rugby, tennis, soccer, volleyball, Frisbee games, hang gliding, skydiving, rock climbing, or using children's playground equipment. Sports and games participation ranged from 34% to 60%, clustered around urban centers (Figure G12). The average number of days of participating in outdoor sports and games activities per year was about 8 days, ranging from 3 to 14 days. Figure G13 shows these data are highest in the northern portion of the state. Participation variables were not significant in the models and therefore dropped from the final models. Duration of use is a better measure of physical activity and is retained in the following models.

There was an average of 0.06 households per acre, ranging from 0 to 0.91. About 19% have a college education, and average commute times was a little over 20-minutes one-way. Thirty-one percent of counties are classified as metropolitan, while 14% are classified as rural. Public acres (federal, state, county, and municipal) made up 46% of the total land base in each county on average, ranging from a low of 9% to a high of 78%.

Table 2. Summary statistics, Oregon counties (n = 36).

Variable	Mean	Std.Dev.	Min	Max
PA	0.44	0.07	0.23	0.54
OW	0.39	0.03	0.30	0.45
OB	0.22	0.04	0.13	0.31
HIKTRL	269.50	271.32	0	1150.00
HIKTRLHH	0.03	0.06	0	0.30
URBTRL	106.22	118.70	0	474.00
URBTRLHH	0.01	0.02	0	0.08
FACILITY	262.72	339.60	15.00	1265.00
FACILITYHH	0.01	0.01	0	0.03
PUBAC	0.46	0.21	0.09	0.78
TRAILP	0.49	0.07	0.34	0.65
ROADP	0.73	0.09	0.53	0.92
SPORTSP	0.47	0.07	0.34	0.60
TRAILD	6.44	2.53	2.80	12.37
ROADD	31.49	5.25	21.58	44.69
SPORTSD	8.30	1.96	3.72	13.87
HHAC	0.06	0.16	0	0.91
COLLEGE	0.19	0.07	0.11	0.47
COMMUTE	20.26	3.67	14.40	30.80
METRO	0.31	0.47	0	1
RURAL	0.14	0.35	0	1

Results of the models using Ordinary Least Squares are reported in Table 3. The estimated coefficients represent the change in the dependent variable (PA, OW, or OB) for a one-unit change in the independent variables. The sign on the coefficient is the direction of the association. These coefficients are estimated associations between the dependent variable and the independent variable, not to be confused with causality. While some of the independent variables may cause changes in the dependent variable, we cannot prove causality with our data.

However, patterns in associations in county-level data mirror physical and behavioral results reported for individual-level data (Rosenberger et al., 2005).

Those coefficients that are statistically different than zero are identified with asterisks (*), where statistical significance tests the hypothesis that the estimated coefficient is different than zero. Standard errors of coefficient estimates are provided in parentheses. Elasticity measures are provided in square-brackets. Elasticities are unitless measures of the relationship between the dependent variable and the independent variables, where the estimated elasticity may be interpreted as the percent change in the dependent variable associated with a one-percent change in the independent variable, evaluated at the mean values for the variables. That is, as we move from county to county, elasticities tell us the general effect of changes in recreation supply and demand on the counties' average physical activity and weight status rates. Overall model goodness of fit is provided by the adjusted-R^2, which may be interpreted as the percent of the variation in the dependent variable explained by the independent variables.

The estimated physical activity model (PA MODEL) explained 30% of the variation in physical activity proportions (PA) as reflected in the adjusted-R^2 value. Overweight (OW) is positively associated with PA—for every 1% increase in OW an associated 0.83% increase in PA. We should be very cautious with interpreting this relationship—one plausible explanation is that as people enter the overweight class, they may become more physically active in an attempt to offset their weight gain, although given the elasticity is less than one, not everyone becomes physically active. Obesity proportions (OB) are not associated with PA. Trails are strongly, positively associated with physical activity. Counties with higher per household densities of trail miles have higher proportions of physically active adults. A 1% increase in hiking trails (HIKTRLHH) or urban trails (URBTRL) is associated with a 0.01% higher physical activity rate. The density of public land (PUBAC) in a county is not significantly related to PA. The frequency of participation in various recreation activities is positively associated with PA across counties. The average annual days households participate in trail or off-trail related activities (TRAILD), in road and street activities (ROADD), and in outdoor sports and games (SPORTSD) are associated with higher PA rates—elasticities range from 0.10% to 0.13% for a 1% increase in annual participation in the various activities. Household density per acre in a county is negatively associated with PA rates, meaning more densely populated counties have lower PA rates.

The estimated overweight model (OW MODEL) explained 46% of the variation in overweight proportions (OW) as reflected in the adjusted-R^2 value. Physical activity (PA) is positively associated with OW—for every 1% increase in PA an associated 0.27% increase in PA. Again, interpretation of this relationship should be cautious—recall PA was found to be endogenously determined. Obesity proportions (OB) are negatively associated with OW—for every 1% increase in OB an associated 0.15% decrease in OW follows—reflecting movement of people into OB from OW. Trails are strongly, negatively associated with physical activity. Counties with higher per household densities of trail miles have lower proportions of overweight adults. A 1% increase in miles/household of hiking trails (HIKTRLHH) is associated with a 0.01% lower overweight rate. Urban trails (URBTRL) are not statistically associated with OW. The frequency of participation in various recreation activities is negatively associated with OW across counties, although road and street activities are not statistically significant. A 1% increase

in trail or off-trail related activities (TRAILD) and in outdoor sports and games (SPORTSD) are associated with 0.07% and 0.08% decreases in OW, respectively. Metropolitan counties had lower OW rates, while rural counties had higher OW rates.

The estimated obesity model (OB MODEL) explained 53% of the variation in obesity proportions (OB) as reflected in the adjusted-R^2 value. This is the only model that explicitly needed to correct for spatial dependence in the form of a spatial error model. Physical activity (PA) and overweight (OW) are not statistically associated with OB. Likewise, trail densities (HIKTRLHH and URBTRLHH) are not significantly associated with OB patterns at the county-level. Only annual days per household participating in trail or off-trail activities (TRAILD) is statistically, negatively associated with OB—a 1% increase in trail or off-trail is associated with a 0.18% reduction in OB. Household density is negatively associated with OB. The more educated a county is as measured by the proportion of 25 or older adults with at least a bachelor's degree (COLLEGE), the lower its OB rate—a 1% increase in COLLEGE has a -0.30% response in OB. Also, counties with longer commute times (COMMUTE), the higher their OB rates—a 1% increase in COMMUTE results in a 0.23% response in OB.

Table 3. Regression results (n = 36).

VARIABLE	PA MODEL	OW MODEL	OB MODEL
Constant	-0.05426 (0.1259)	0.4296*** (0.0397)	0.3689*** (0.0700)
PA	Dependent variable	0.2374*** (0.0690) [0.2714]	-0.0803 (0.0835) [-0.1621]
OW	0.9531*** (0.2559) [0.8342]	Dependent variable	-0.1804 (0.1399) [-0.3186]
OB	-0.0448 (0.2232) [-0.0222]	-0.2688** (0.0994) [-0.1522]	Dependent variable
HIKTRLHH	0.1612** (0.0792) [0.0119]	-0.1348** (0.0500) [-0.0113]	-0.1160 (0.0806) [-0.0172]
URBTRLHH	0.7185** (0.2988) [0.0133]	-0.2298 (0.2748) [-0.0048]	0.0049 (0.3712) [0.0002]
PUBAC	-0.0461 (0.0496) [-0.0478]	---	---
TRAILD	0.0070** (0.0030) [0.1016]	-0.0043** (0.0020) [-0.0713]	-0.0060** (0.0029) [-0.1757]]
ROADD	0.0018* (0.0010) [0.1277]	-0.0005 (0.0008) [-0.0405]	0.0002 (<0.0001) [0.0286]
SPORTSD	0.0059* (0.0031) [0.1103]	-0.0037** (0.0018) [-0.0790]	0.0014 (0.0024) [0.0528]
HHAC	-0.0556** (0.0251) [-0.0073]	---	-0.0669** (0.0291) [-0.0177]
METRO	---	-0.0368*** (0.0081)	---
RURAL	---	0.0272** (0.0122)	---
COLLEGE	---	---	-0.3457*** (0.0606) [-0.3014]
COMMUTE	---	---	0.0025** (0.0012) [0.2302]
λ	---	---	-0.9900*** (0.2075)
Adj-R^2	0.30	0.46	0.53

Standard errors in parentheses; elasticities in square-brackets calculated at mean values.
***p-value<0.01; **p-value<0.05; *p-value<0.1

SUMMARY

The objective of this study was to evaluate the relationship between the supply and demand of recreation opportunities in Oregon and measures of health status (physical activity, overweight, and obesity) at the county-level. Overweight and obesity are significant health concerns in the US. However, regular physical activity can attenuate many of the health risks associated with weight status. In fact, the literature shows that physical activity lowers health risks regardless of weight class. Therefore, compelling arguments to get people active are the health benefits derived from a physically active lifestyle. While Oregon is doing better, on average, than the nation regarding proportion of adults that are physically active, there are still significant health benefits to be gained by increasing the physical activity levels of adults in Oregon.

Recreation is one mode through which people may accumulate their recommended daily doses of physical activity. Multivariate regression analyses show that more hiking and urban trails are associated with higher physical activity rates. The models also show that counties in which people are more engaged in trail-related activities, road and street activities (walking, jogging, biking), and outdoor sports, their overall physical activity rates are higher. Therefore, parks and recreation providers have a significant social role to play in the health and well-being of Oregon's residents.

RECOMMENDATIONS

1. *Support close-to-home non-motorized trail development.* Trails provide an important opportunity for people to be physically active. Accessibility is one of the primary attributes of trails, including distance from home. Close-to-home trails provide opportunities for daily doses of physical activity, where remote trails provide other opportunities not available in local trails.

2. *Identify at risk communities*. Health risks, as proportions of county residents, vary across Oregon. We show that this pattern is associated with the distribution and use of recreation opportunities in the form of trail mile density and intensity of use (annual days of participation). Therefore, at risk communities might be those with higher proportions of adults in health risk categories, whose trends in health risk categories are flat or trending in the wrong direction, and/or are associated with inactive environments (low recreation opportunities in terms of availability, accessibility and diversity).

   The Population Research Center, Portland State University has projected health status indicators to 2020 for Oregon Parks and Recreation Department. Those counties with relatively low (<50%) proportions of adults that meet recommended levels of physical activity and/or are trending downward over time have been identified as 'in need' counties. This classification could be used to target funds in support of trail development, educational programs, and marketing aimed at getting people active in their environments.

3. *Promote the use of existing trail networks by providing information on existing trails.* People may not be aware of places to recreate. Increasing their awareness may help them become more active. An example is the trails website development by Oregon Parks and Recreation Department that is currently underway.

4. *Market the health benefits of outdoor recreation, but note the importance of nutrition in a weight loss regimen.* Physical activity promotes good health, regardless of weight class. While physical activity may help prevent weight gain, it may be necessary, but is not sufficient for weight loss. Therefore, a media campaign should focus on health, not weight. For example, a chart that shows the potential health gains from various types of activities by frequency and duration of participation may help keep people motivated. People need to be aware that even though they may not be lowering their weight, they are lowering their health risks of various chronic diseases. Furthermore, recreation may be prescribed by physicians as an important disease prevention program.

5. *Target at-risk people and communities.* Target at-risk people and communities by identifying their preferences for trail attributes, supply gaps in trail networks, and their physical and perceived barriers to participating in physical activity/recreation. Getting sedentary people physically active will lead to health benefits for them and a reduction in the health care burden on society.

   Gaps in recreation supply are not simply the lack of facilities (although this is important), but also their location (accessibility) and diversity of opportunities (trails, settings, social events, etc.). Identifying gaps may need to be user driven—who is using resources and why; who is not using resources and why; and what resources would they use that are currently not available to them.

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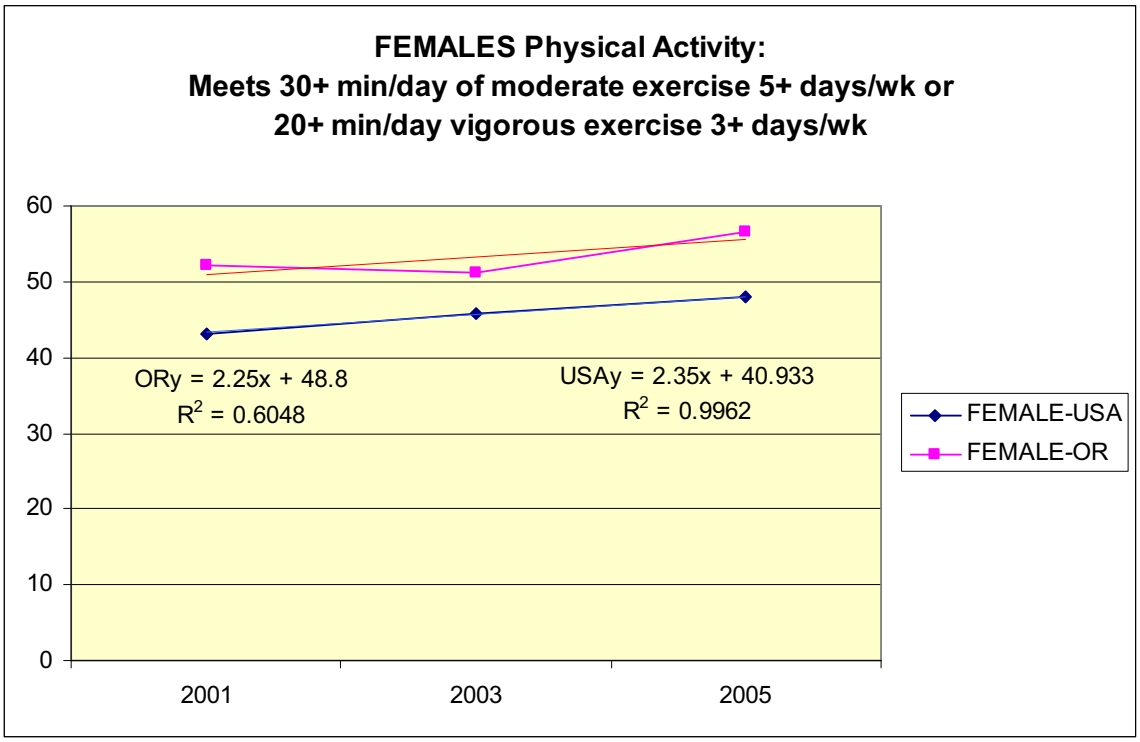
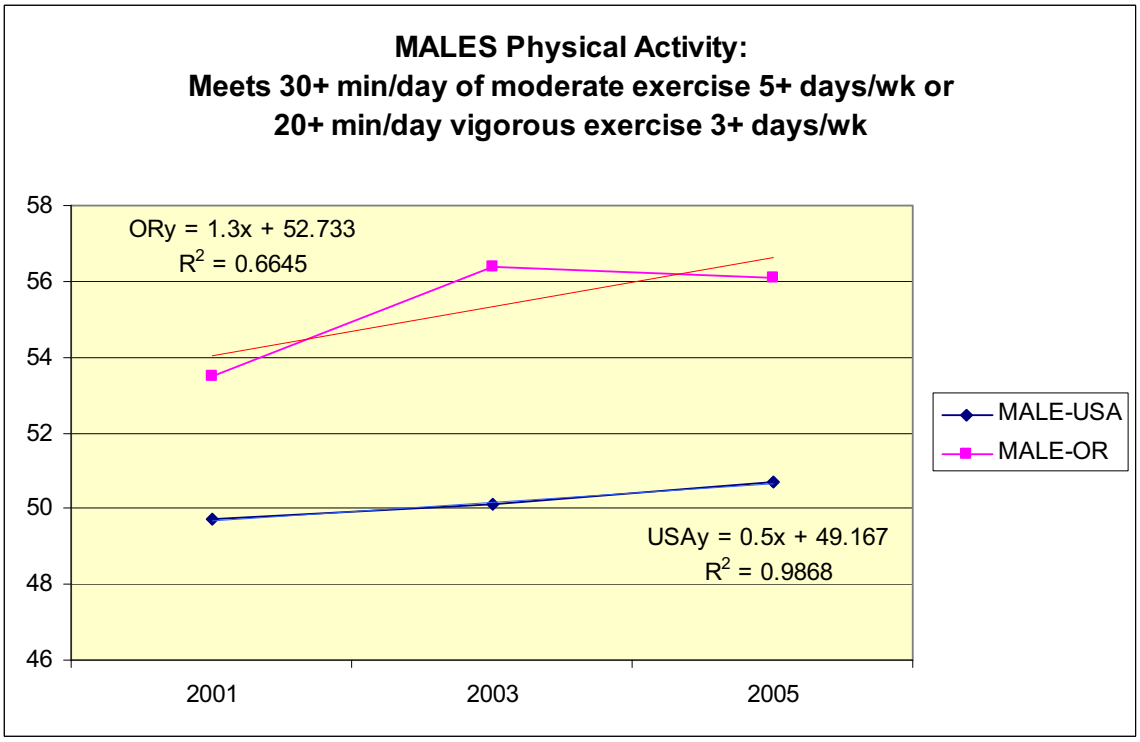
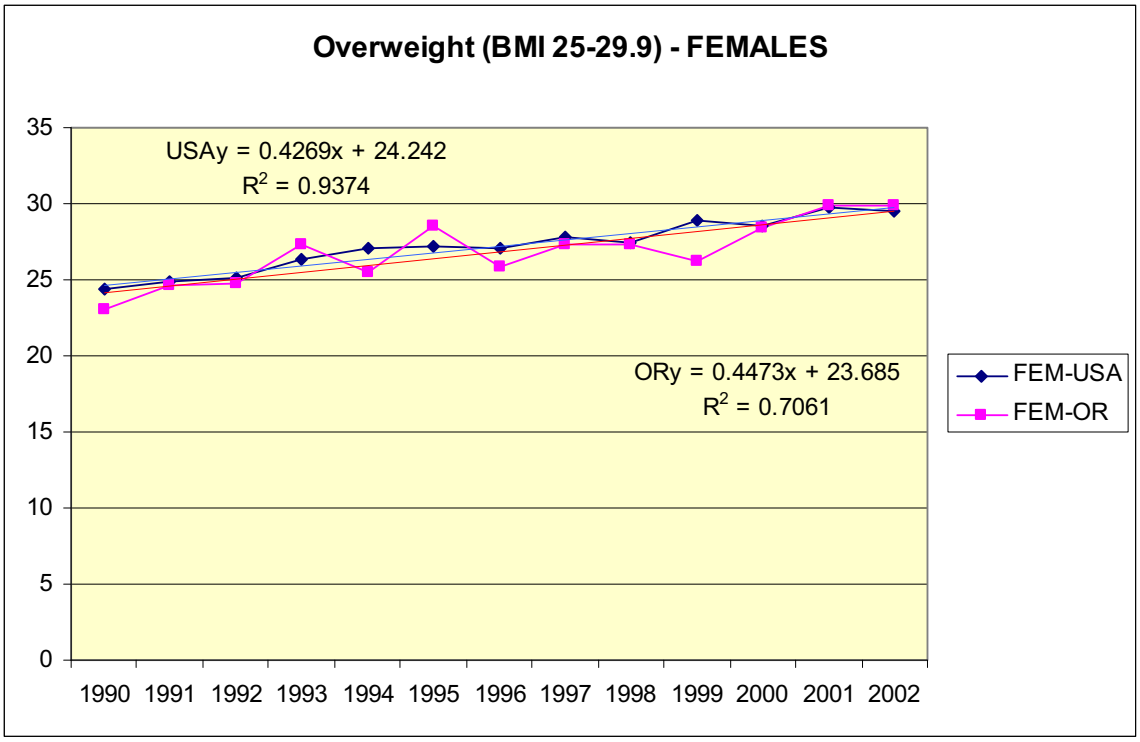
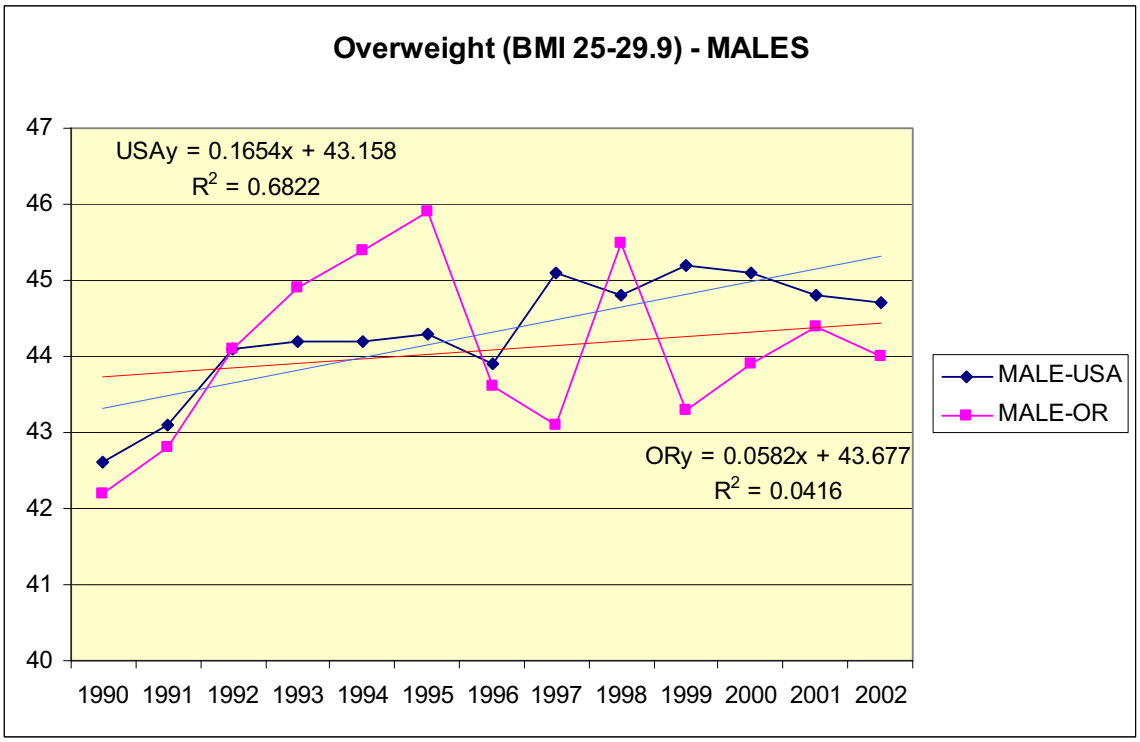
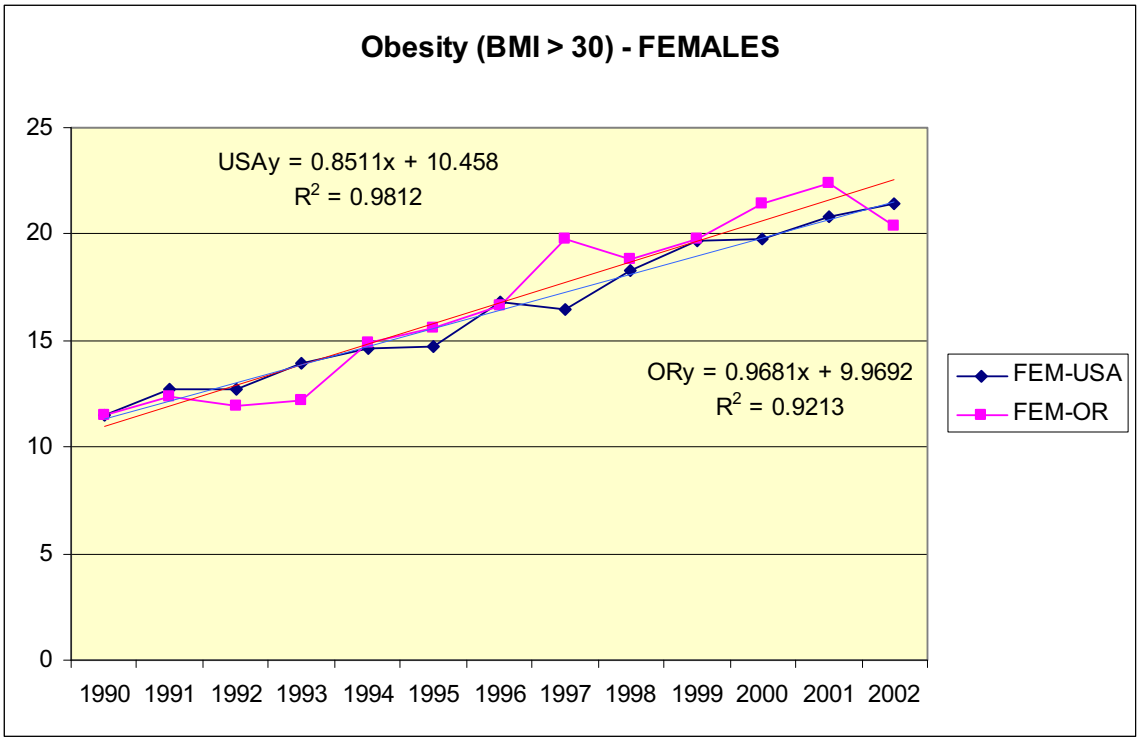
APPENDIX A: Trends in Physical Activity, Overweight and Obesity by Gender for the US and Oregon (Source: BRFSS Data)

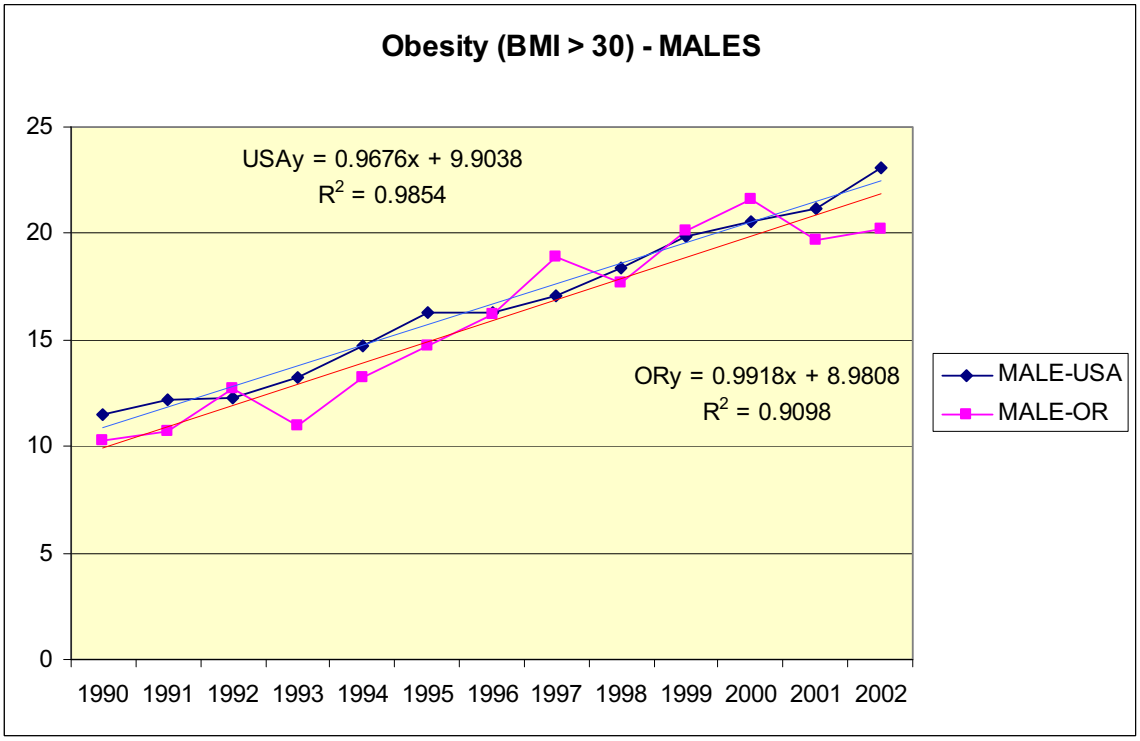




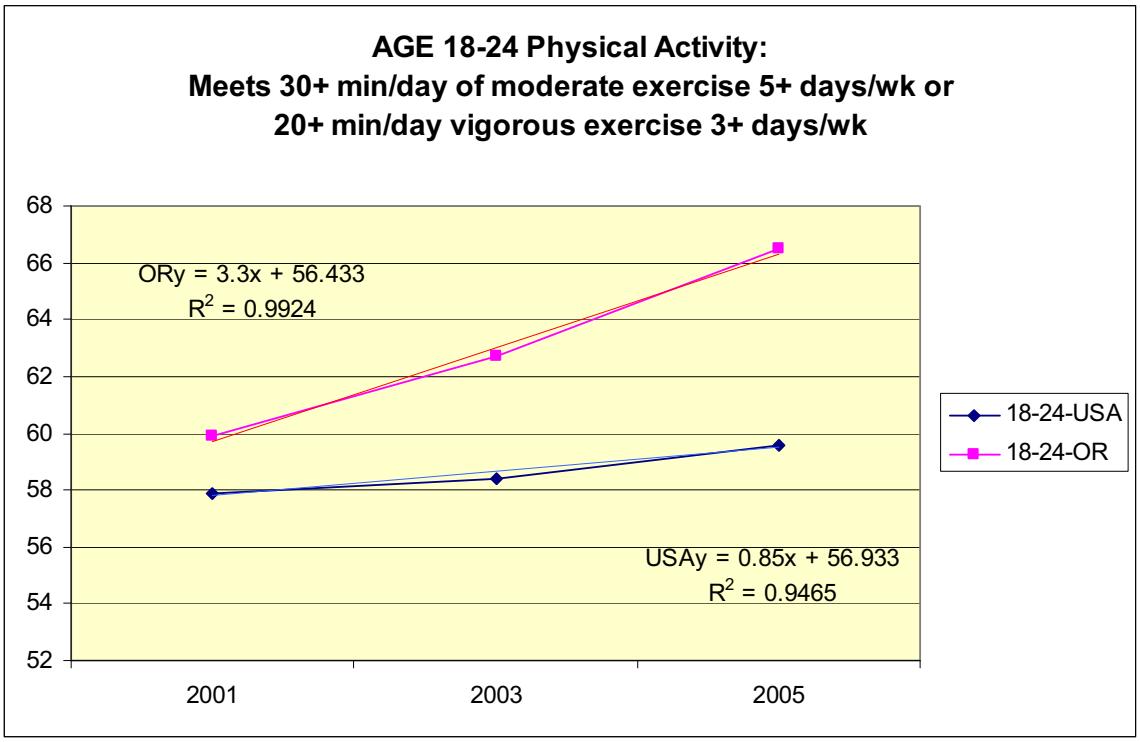

Overweight (BMI 25-29.9) - FEMALES
USAy = 0.4269x + 24.242
R2 = 0.9374
ORy = 0.4473x + 23.685
R2 = 0.7061
FEM-USA
FEM-OR
35
30
25
20
15
10
5
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002

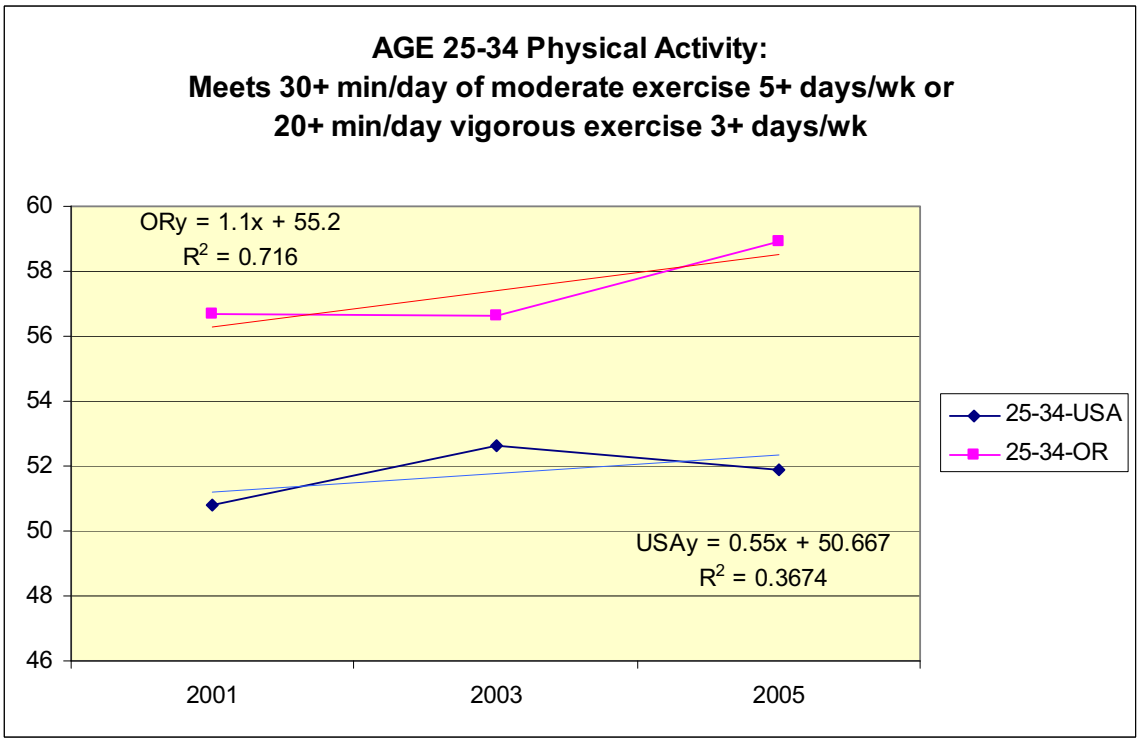

Overweight (BMI 25-29.9) - MALES
USAy = 0.1654x + 43.158
R2 = 0.6822
ORy = 0.0582x + 43.677
R2 = 0.0416
MALE-USA
MALE-OR
47
46
45
44
43
42
41
40
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002

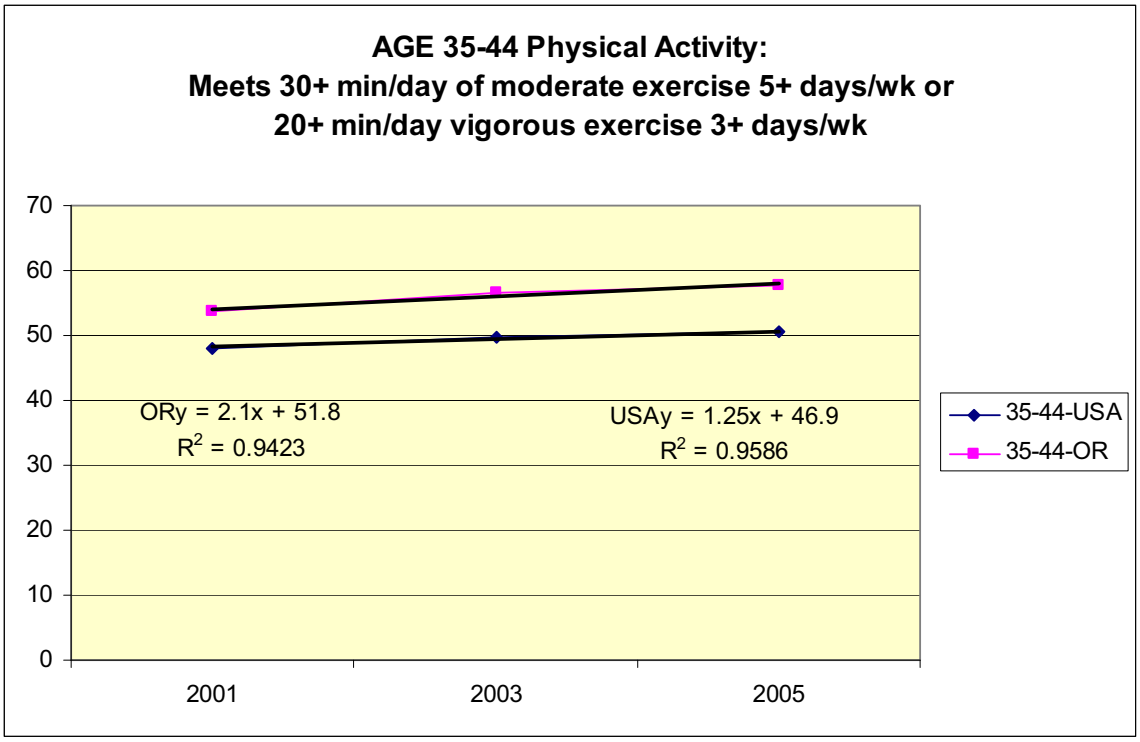

Obesity (BMI > 30) - FEMALES
USAy = 0.8511x + 10.458
R2 = 0.9812
ORy = 0.9681x + 9.9692
R2 = 0.9213
FEM-USA
FEM-OR
25
20
15
10
5
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002

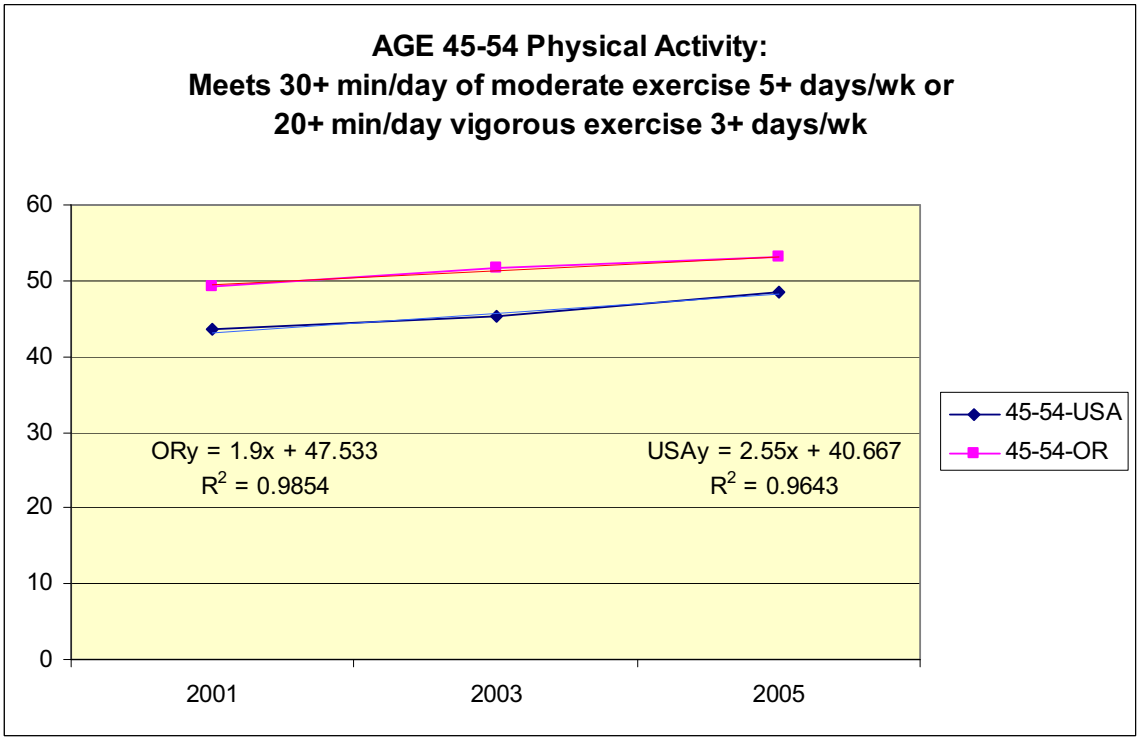

Obesity (BMI > 30) - MALES
USAy = 0.9676x + 9.9038
R2 = 0.9854
ORy = 0.9918x + 8.9808
R2 = 0.9098
MALE-USA
MALE-OR
25
20
15
10
5
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002

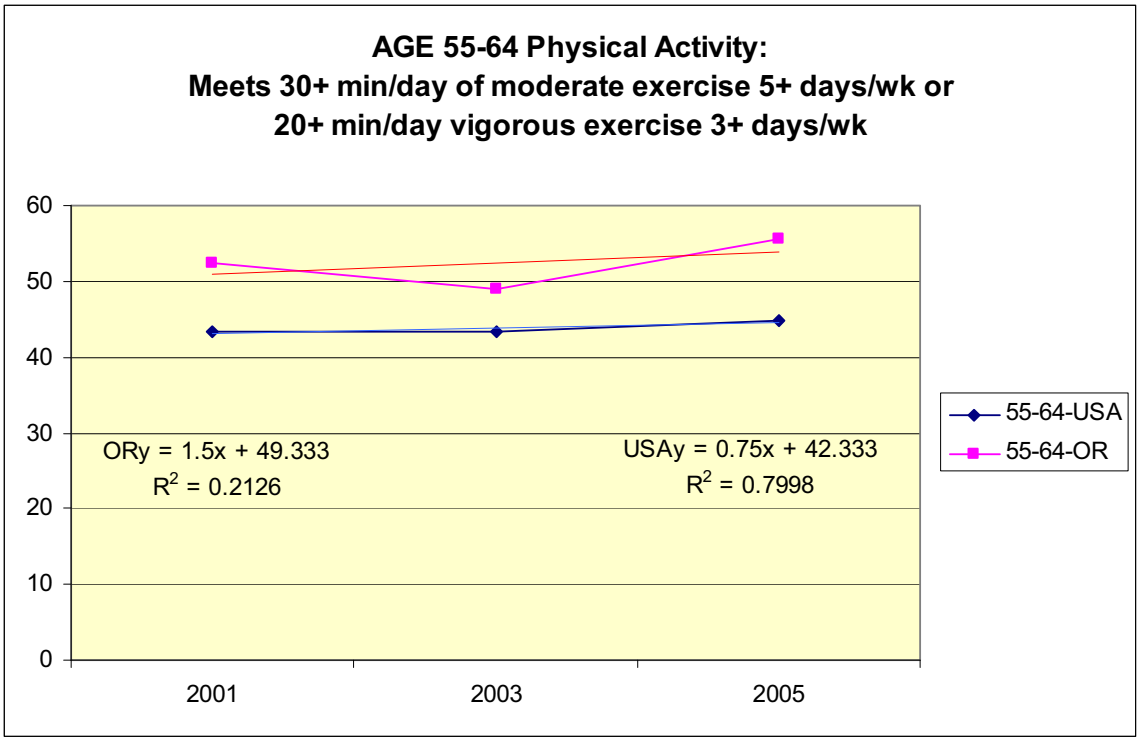
APPENDIX B: Trends in Physical Activity, Overweight and Obesity by Age Class for the US and Oregon (Source: BRFSS Data)

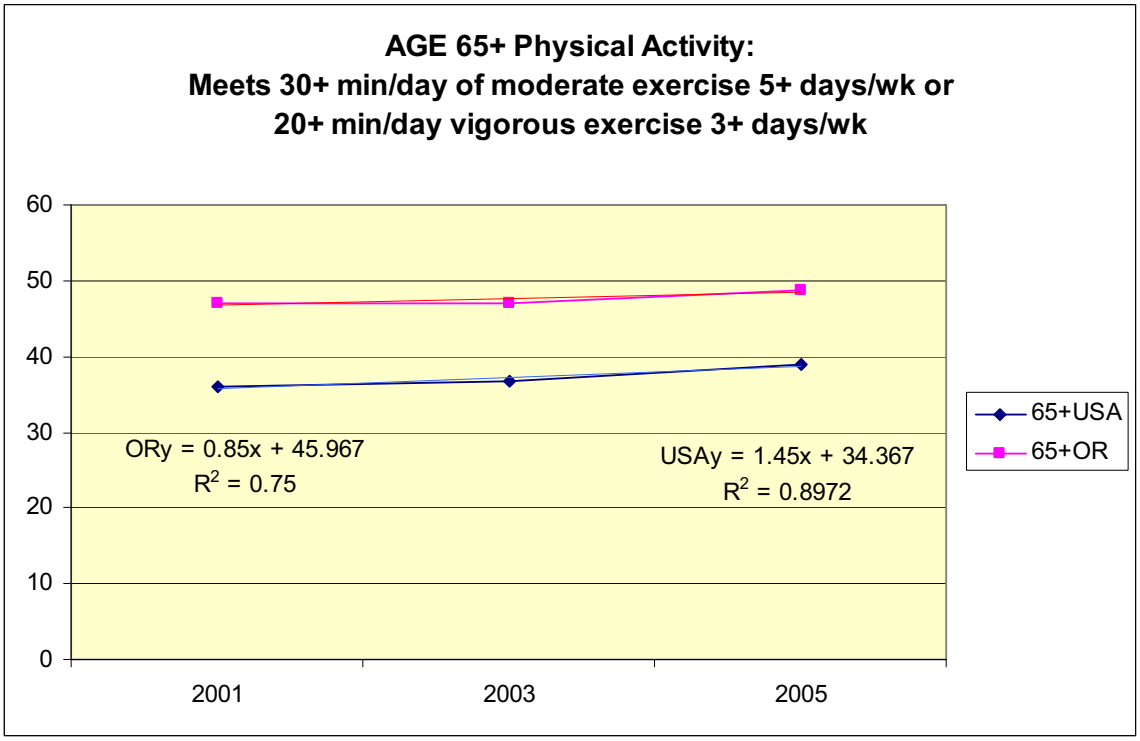


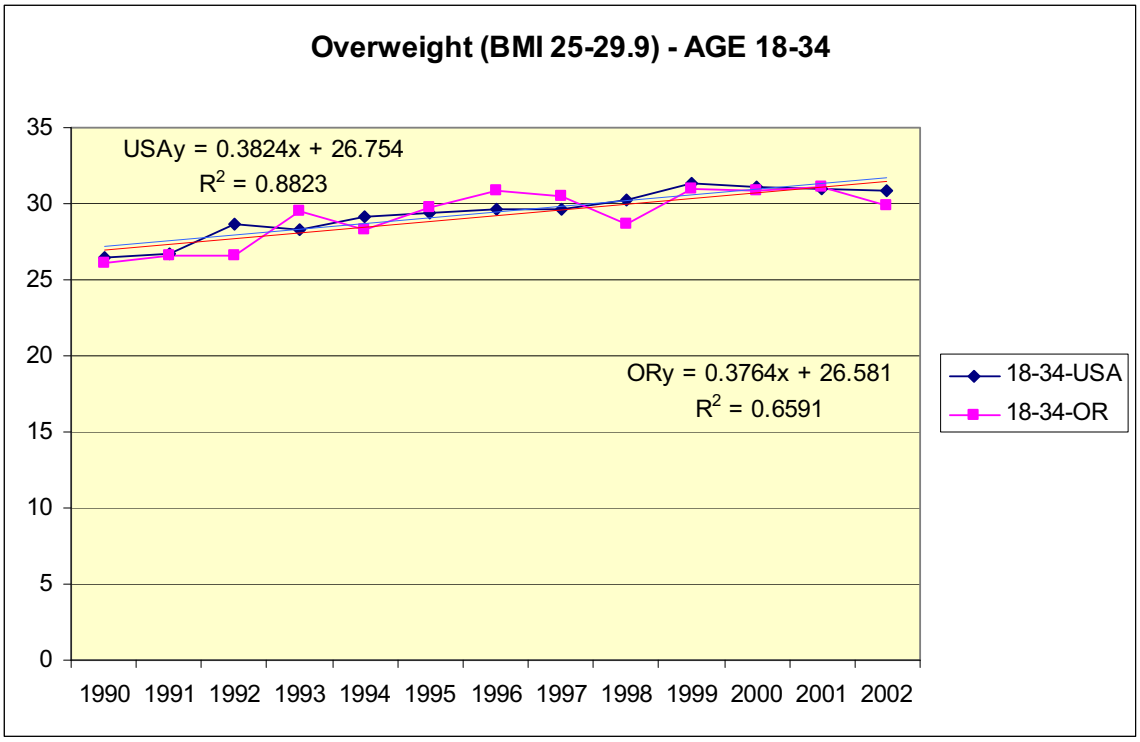


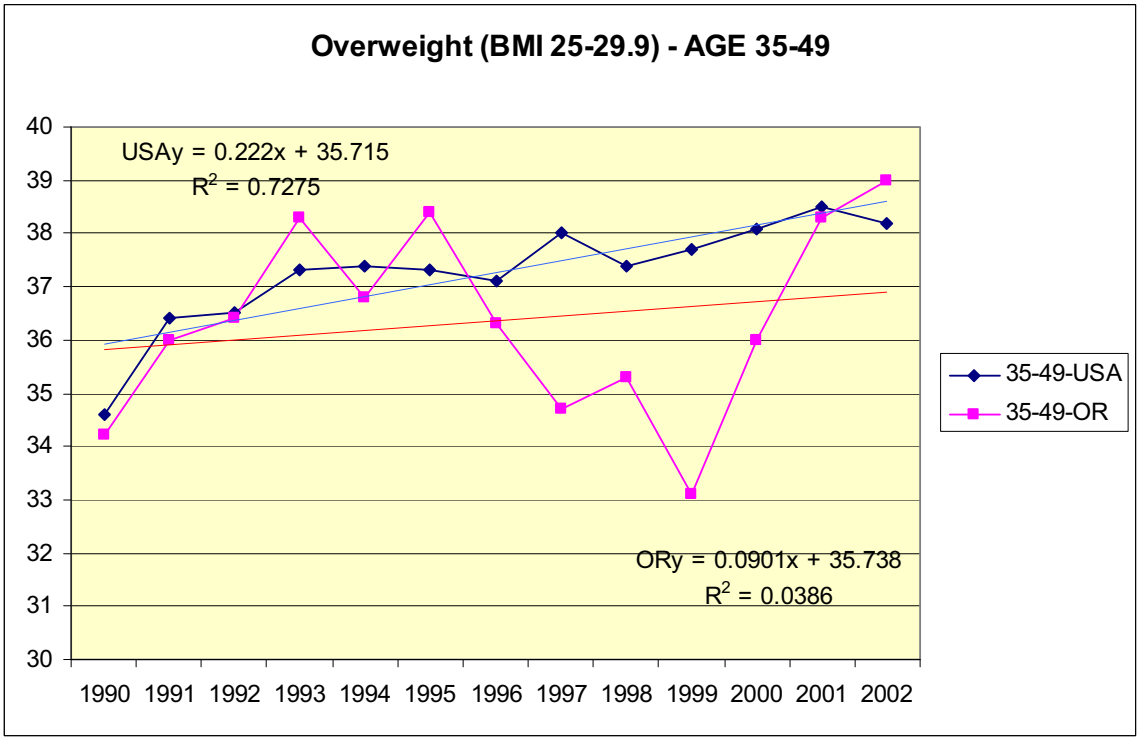

AGE 35-44 Physical Activity:
Meets 30+ min/day of moderate exercise 5+ days/wk or
20+ min/day vigorous exercise 3+ days/wk
70
60
50
40
30
20
10
0
2001
2003
2005
ORy = 2.1x + 51.8
R2 = 0.9423
USAy = 1.25x + 46.9
R2 = 0.9586
35-44-USA
35-44-OR

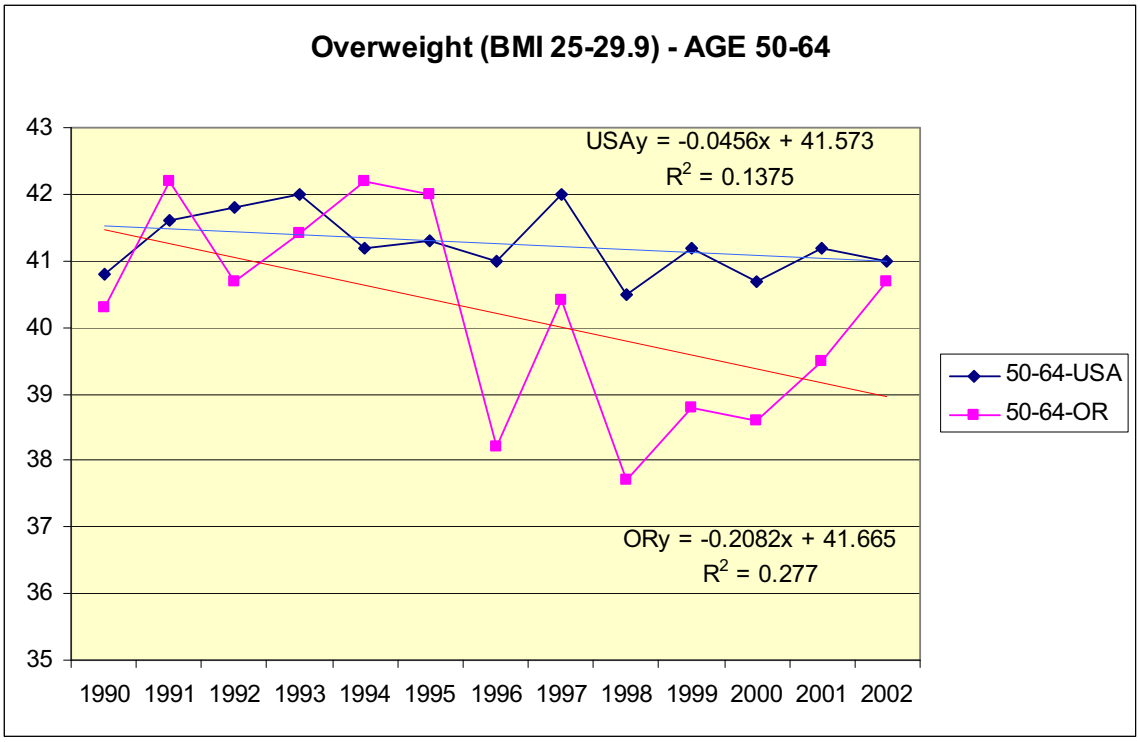

AGE 45-54 Physical Activity:
Meets 30+ min/day of moderate exercise 5+ days/wk or
20+ min/day vigorous exercise 3+ days/wk
60
50
40
30
20
10
0
2001
2003
2005
ORy = 1.9x + 47.533
R2 = 0.9854
USAy = 2.55x + 40.667
R2 = 0.9643
45-54-USA
45-54-OR

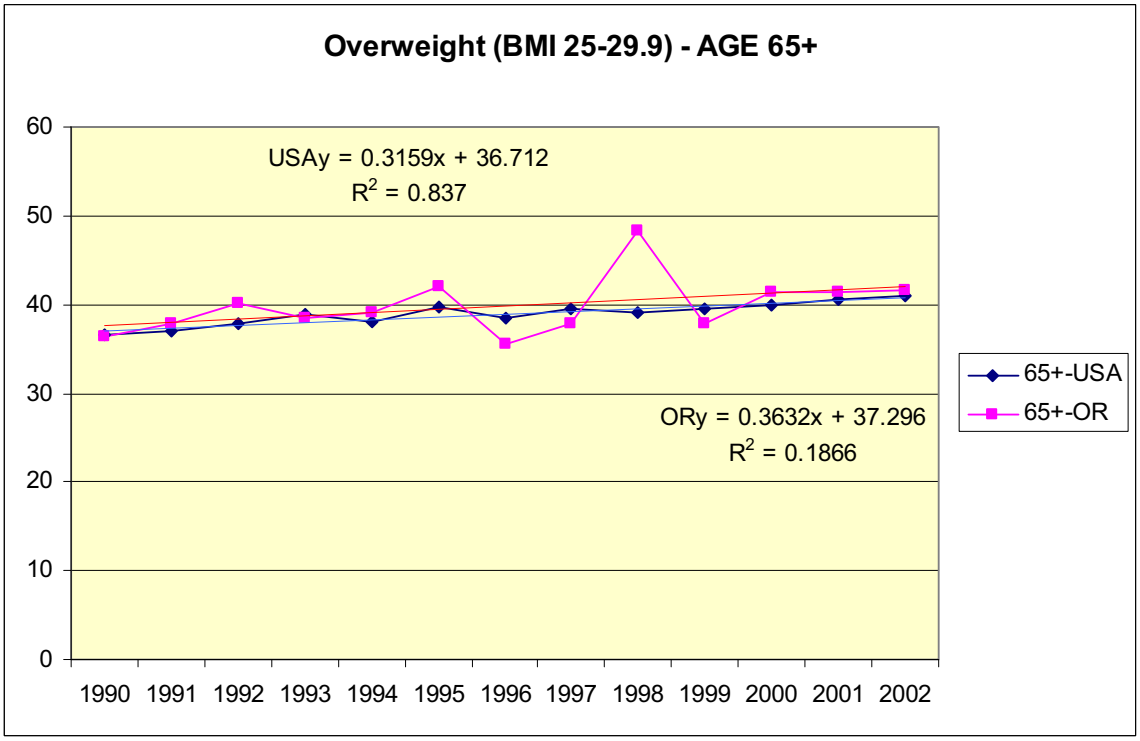

AGE 55-64 Physical Activity:
Meets 30+ min/day of moderate exercise 5+ days/wk or
20+ min/day vigorous exercise 3+ days/wk
60
50
40
30
20
10
0
2001
2003
2005
ORy = 1.5x + 49.333
R2 = 0.2126
USAy = 0.75x + 42.333
R2 = 0.7998
55-64-USA
55-64-OR

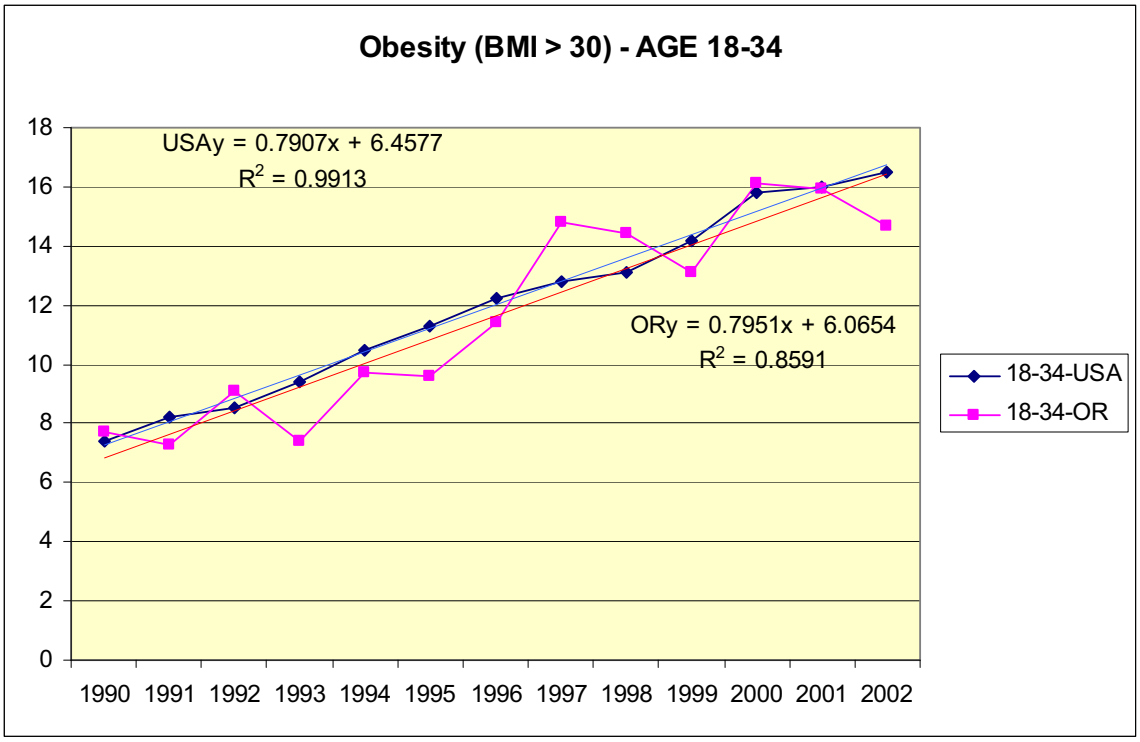

AGE 65+ Physical Activity:
Meets 30+ min/day of moderate exercise 5+ days/wk or
20+ min/day vigorous exercise 3+ days/wk
60
50
40
30
20
10
0
2001
2003
2005
ORy = 0.85x + 45.967
R2 = 0.75
USAy = 1.45x + 34.367
R2 = 0.8972
65+USA
65+OR

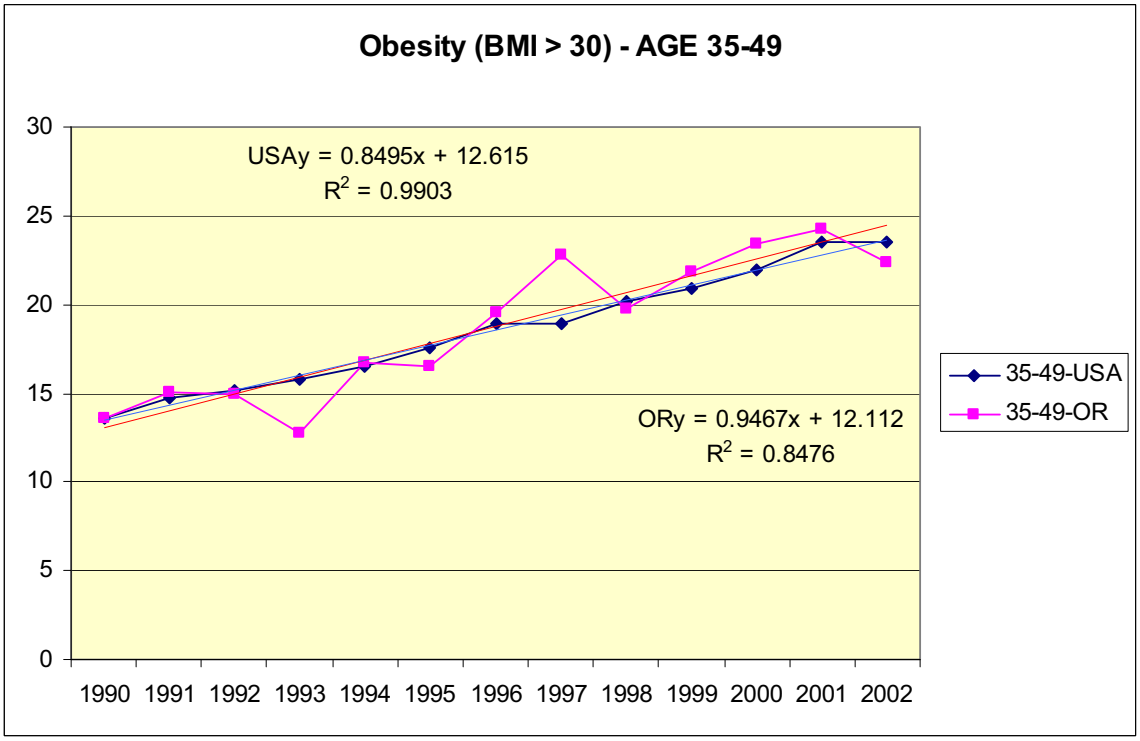

Overweight (BMI 25-29.9) - AGE 18-34
USAy = 0.3824x + 26.754
R2 = 0.8823
ORy = 0.3764x + 26.581
R2 = 0.6591
18-34-USA
18-34-OR
35
30
25
20
15
10
5
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002

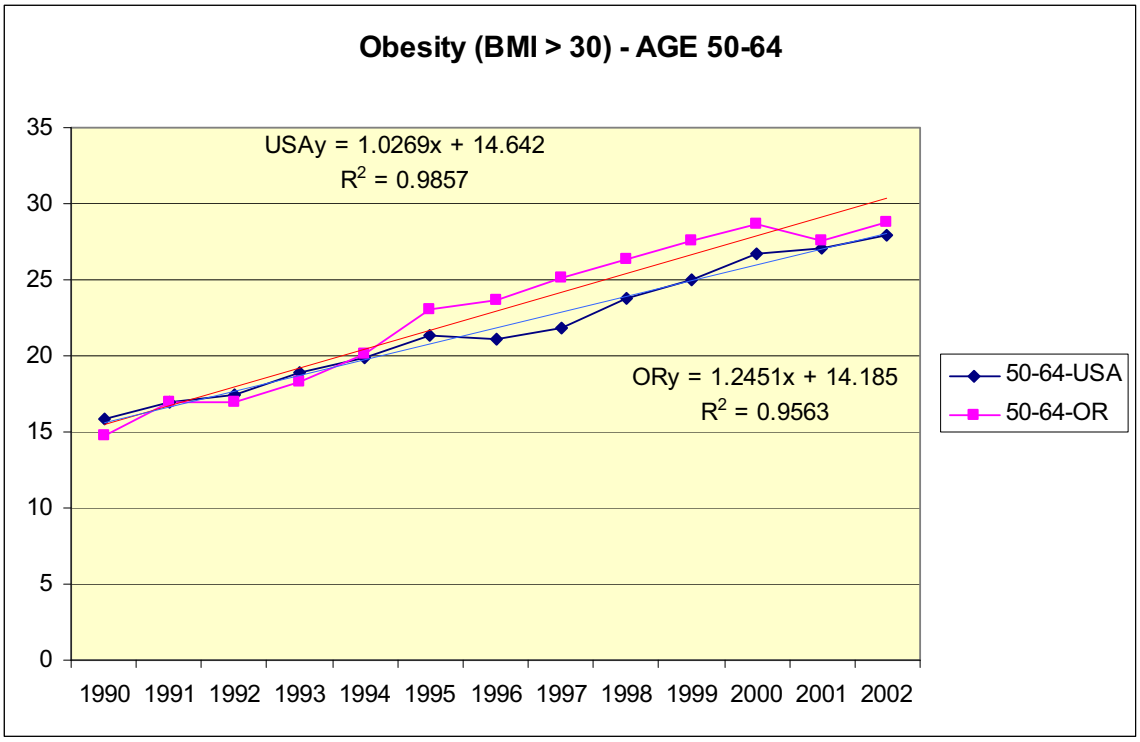

Overweight (BMI 25-29.9) - AGE 35-49
USAy = 0.222x + 35.715
R2 = 0.7275
ORy = 0.0901x + 35.738
R2 = 0.0386
35-49-USA
35-49-OR
40
39
38
37
36
35
34
33
32
31
30
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002

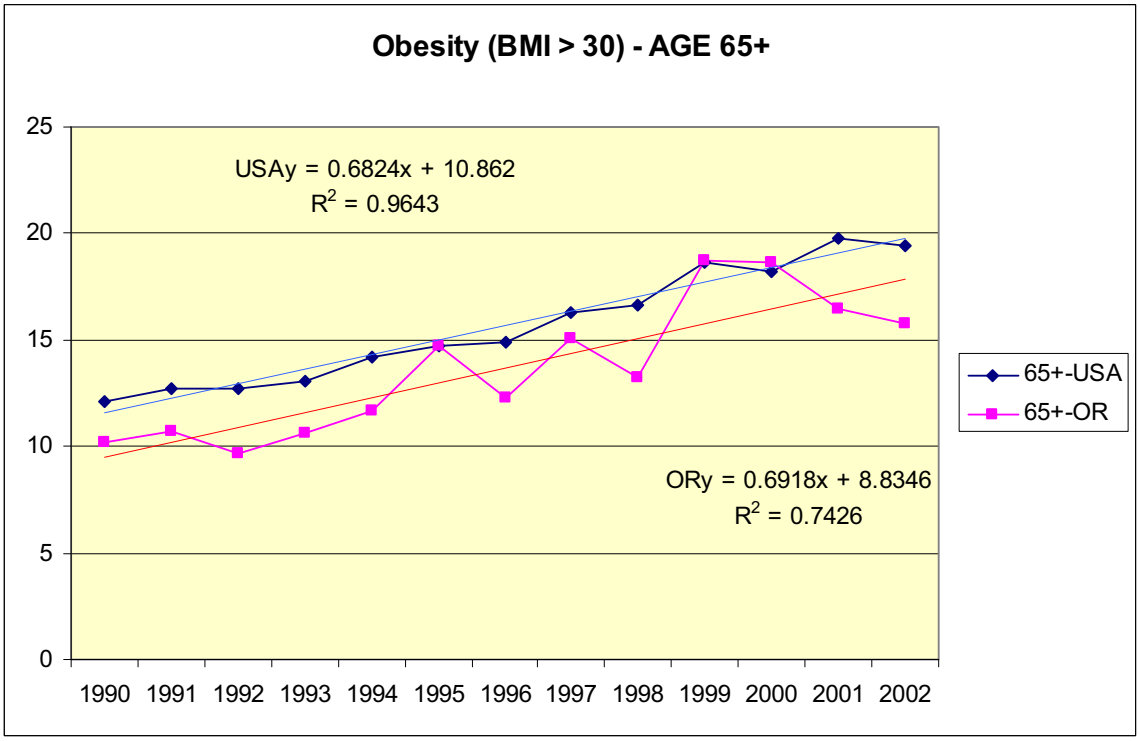

Overweight (BMI 25-29.9) - AGE 50-64
USAy = -0.0456x + 41.573
R2 = 0.1375
ORy = -0.2082x + 41.665
R2 = 0.277
50-64-USA
50-64-OR
43
42
41
40
39
38
37
36
35
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002


Overweight (BMI 25-29.9) - AGE 65+
USAy = 0.3159x + 36.712
R2 = 0.837
ORy = 0.3632x + 37.296
R2 = 0.1866
65+-USA
65+-OR
60
50
40
30
20
10
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002


Obesity (BMI > 30) - AGE 18-34
USAy = 0.7907x + 6.4577
R2 = 0.9913
ORy = 0.7951x + 6.0654
R2 = 0.8591
18-34-USA
18-34-OR
0
2
4
6
8
10
12
14
16
18
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002


Obesity (BMI > 30) - AGE 35-49
USAy = 0.8495x + 12.615
R2 = 0.9903
ORy = 0.9467x + 12.112
R2 = 0.8476
35-49-USA
35-49-OR
0
5
10
15
20
25
30
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002


Obesity (BMI > 30) - AGE 50-64
USAy = 1.0269x + 14.642
R2 = 0.9857
ORy = 1.2451x + 14.185
R2 = 0.9563
50-64-USA
50-64-OR
35
30
25
20
15
10
5
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002


Obesity (BMI > 30) - AGE 65+
USAy = 0.6824x + 10.862
R2 = 0.9643
ORy = 0.6918x + 8.8346
R2 = 0.7426
65+-USA
65+-OR
25
20
15
10
5
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002

APPENDIX C: Oregon Counties' Proportions and Rates of Change for Physical Activity, Overweight and Obesity, 2001-2005.

Proportions of adults in Oregon counties, 2001 and 2005.

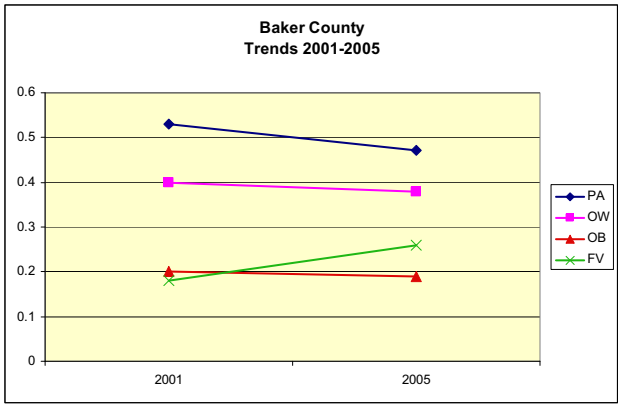
COUNTY	Physical Activity, 2001	Physical Activity, 2005	Overweight, 2001	Overweight, 2005	Obese, 2001	Obese, 2005
Baker	53%	47%	40%	38%	20%	19%
Benton	43%	59%	35%	36%	14%	15%
Clackamas	43%	54%	40%	38%	18%	21%
Clatsop	44%	56%	37%	34%	23%	26%
Columbia	52%	55%	35%	36%	26%	31%
Coos	43%	59%	41%	39%	23%	24%
Crook	46%	55%	41%	45%	20%	24%
Curry	48%	58%	38%	40%	24%	17%
Deschutes	44%	57%	39%	39%	13%	18%
Douglas	23%	51%	37%	38%	28%	27%
Gilliam	46%	65%	43%	30%	24%	34%
Grant	50%	68%	37%	45%	18%	23%
Harney	52%	57%	43%	47%	24%	27%
Hood River	43%	44%	42%	40%	21%	20%
Jackson	41%	58%	35%	36%	24%	21%
Jefferson	45%	51%	40%	43%	30%	29%
Josephine	37%	54%	36%	35%	20%	24%
Klamath	44%	53%	35%	40%	28%	23%
Lake	49%	63%	42%	39%	19%	26%
Lane	44%	59%	36%	36%	20%	23%
Lincoln	43%	51%	38%	40%	21%	27%
Linn	35%	54%	40%	35%	21%	31%
Malheur	46%	47%	40%	40%	19%	30%
Marion	35%	50%	38%	39%	21%	25%
Morrow	44%	40%	37%	46%	31%	29%
Multnomah	37%	56%	35%	34%	19%	19%
Polk	52%	58%	40%	37%	24%	21%
Sherman	54%	63%	45%	36%	23%	24%
Tillamook	50%	50%	40%	41%	20%	22%
Umatilla	43%	38%	36%	40%	27%	26%
Union	51%	61%	42%	40%	19%	20%
Wallowa	51%	52%	40%	39%	17%	11%
Wasco	54%	63%	45%	36%	23%	24%
Washington	37%	52%	38%	37%	19%	20%
Wheeler	46%	65%	43%	30%	24%	34%
Yamhill	31%	56%	30%	36%	27%	26%
AVERAGE	44%	55%	39%	38%	22%	24%
MIN	23%	38%	30%	30%	13%	11%
MAX	54%	68%	45%	47%	31%	34%

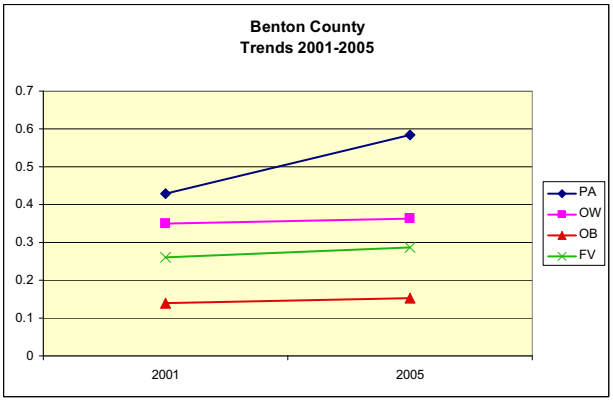
Source: ODHS, 2003, 2007.

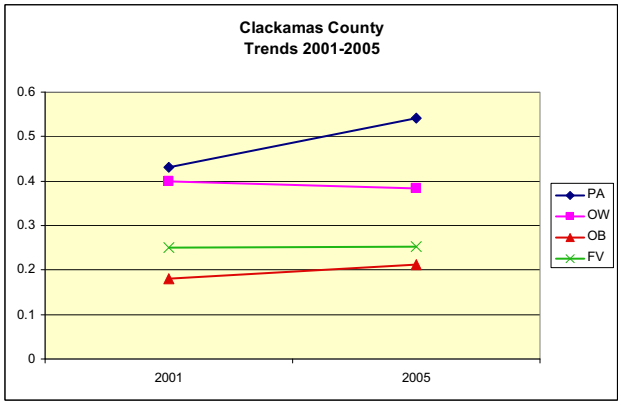
Percent change in proportions for physical activity, overweight and obesity in Oregon's counties, 2001-2005.

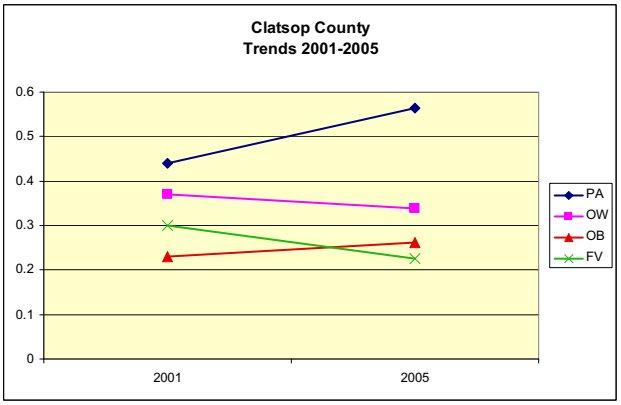
COUNTY	% Change in Physical Activity, 2001-2005	% Change in Overweight, 2001-2005	% Change in Obesity, 2001-2005
Baker	-11	-5	-5
Benton	36	4	9
Clackamas	26	-4	17
Clatsop	28	-8	14
Columbia	6	4	20
Coos	36	-6	3
Crook	19	10	22
Curry	20	6	-28
Deschutes	30	1	42
Douglas	123	3	-4
Gilliam	41	-30	40
Grant	36	23	29
Harney	9	10	14
Hood River	2	-6	-7
Jackson	41	4	-12
Jefferson	12	6	-4
Josephine	46	-3	18
Klamath	21	13	-17
Lake	28	-7	37
Lane	33	-1	14
Lincoln	19	5	29
Linn	55	-12	46
Malheur	2	1	56
Marion	42	4	19
Morrow	-8	25	-6
Multnomah	52	-2	2
Polk	12	-7	-13
Sherman	17	-20	5
Tillamook	0	2	9
Umatilla	-12	12	-4
Union	19	-5	7
Wallowa	3	-3	-33
Wasco	17	-20	5
Washington	41	-4	7
Wheeler	41	-30	40
Yamhill	81	20	-3
AVERAGE	27	-1	10
MIN	-12	-30	-33
MAX	123	25	56

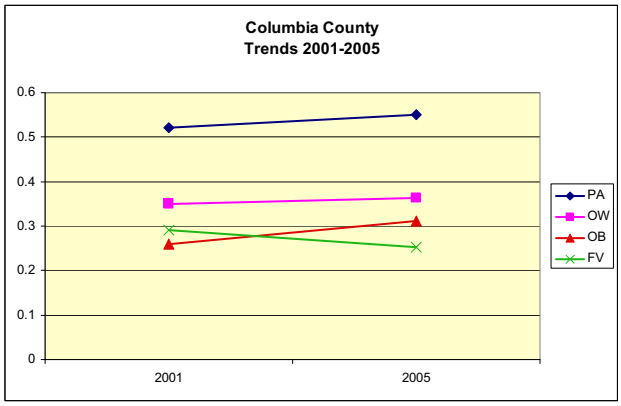
Source: ODHS, 2003, 2007.

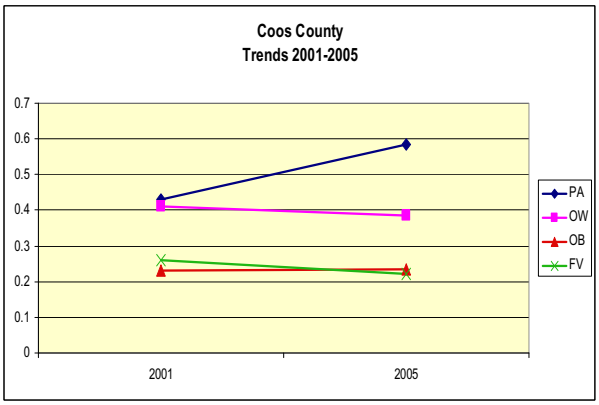

Baker County
Trends 2001-2005
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV

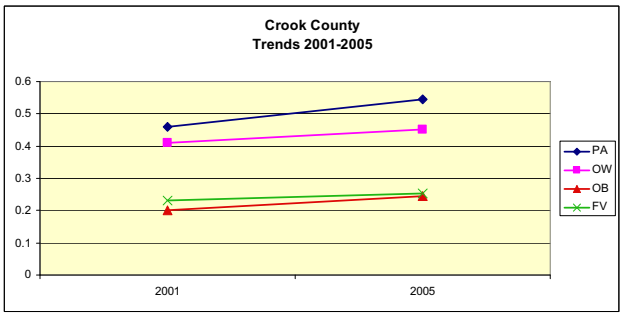

Benton County
Trends 2001-2005
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV

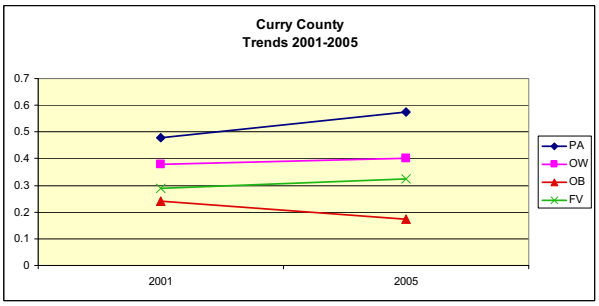

Clackamas County
Trends 2001-2005
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV

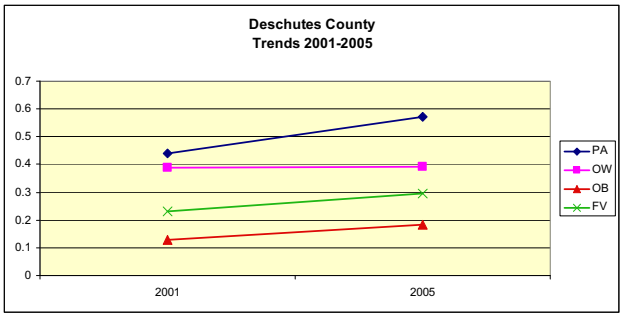

Clatsop County
Trends 2001-2005
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV

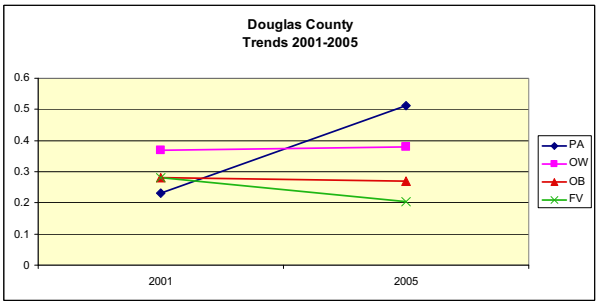

Columbia County
Trends 2001-2005
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV

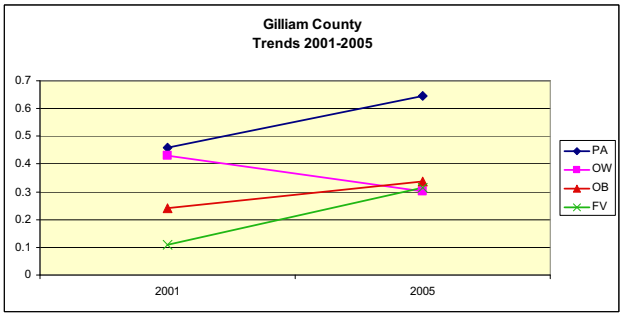

Coos County
Trends 2001-2005
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV

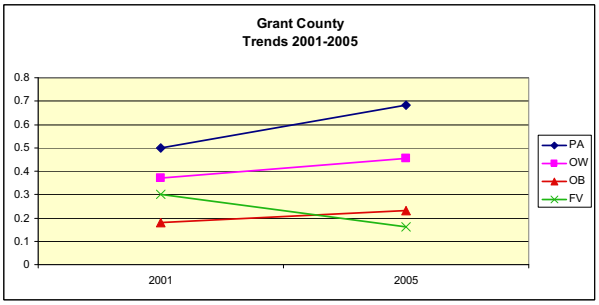

Crook County
Trends 2001-2005
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV

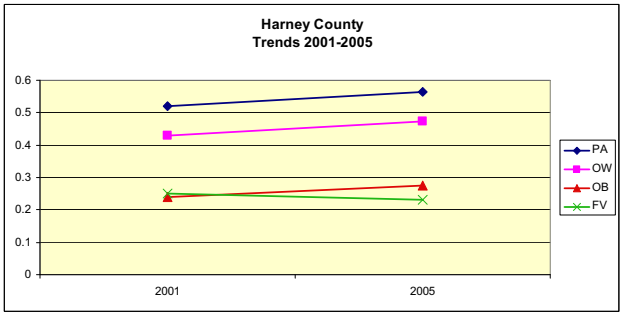

Curry County
Trends 2001-2005
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV

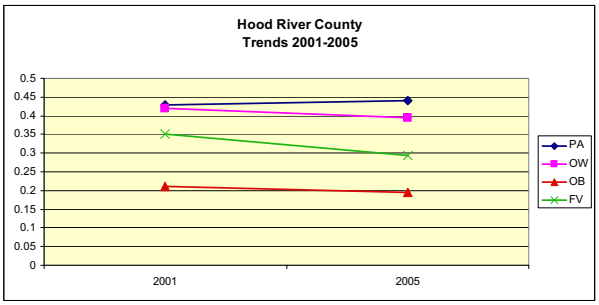

Deschutes County
Trends 2001-2005
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV


Douglas County
Trends 2001-2005
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV


Gilliam County
Trends 2001-2005
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV


Grant County
Trends 2001-2005
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV


Harney County
Trends 2001-2005
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2005
PA
OW
OB
FV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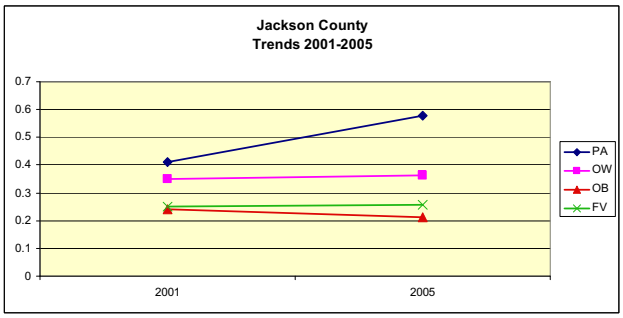
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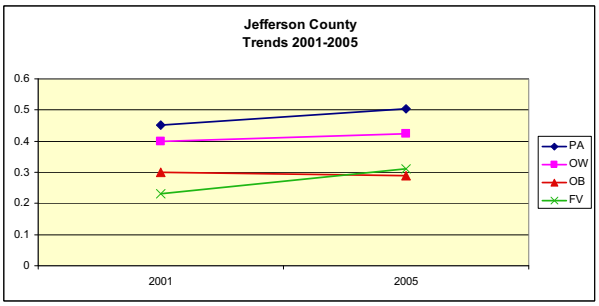
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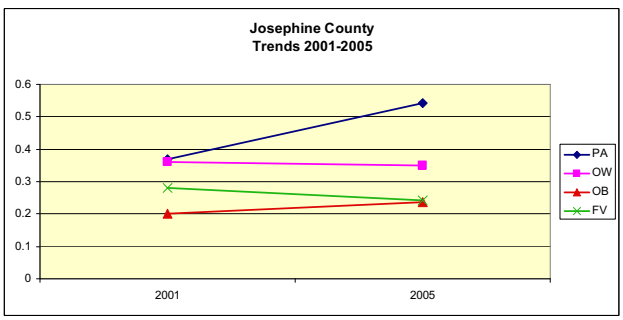
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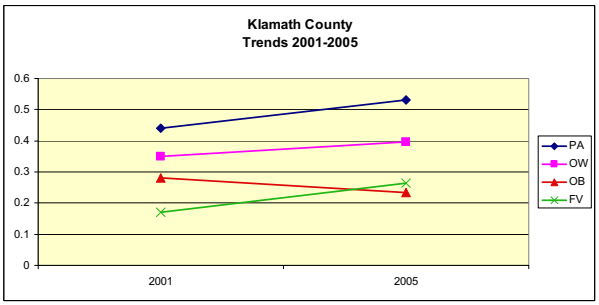
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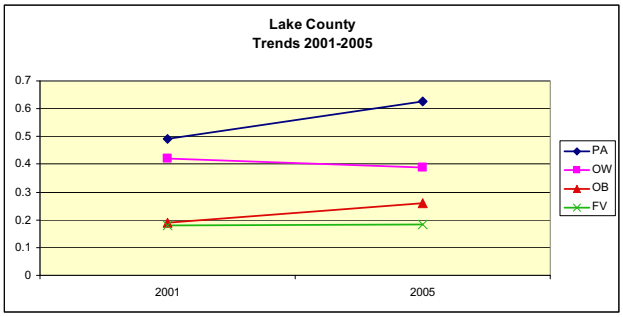
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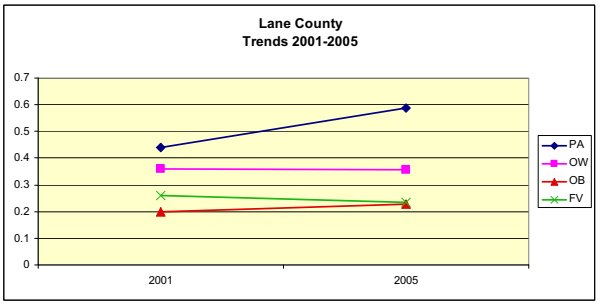
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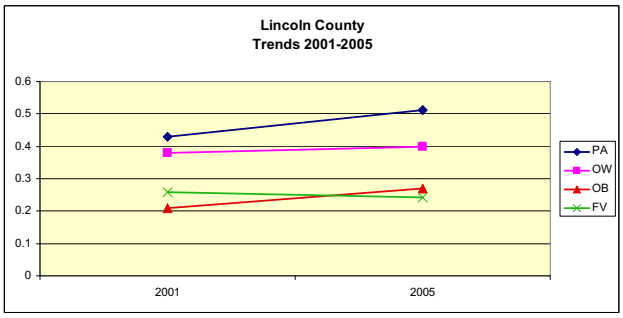
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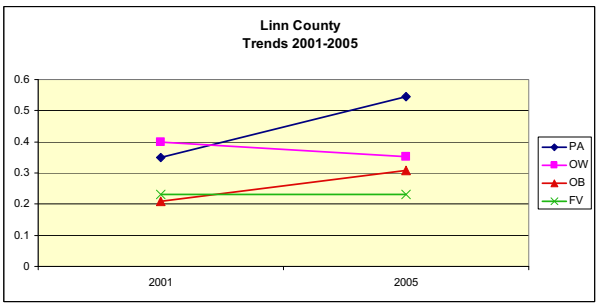
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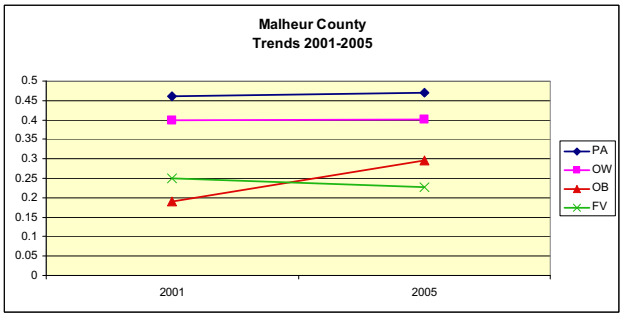
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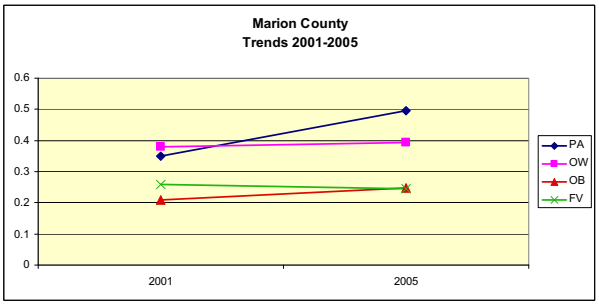
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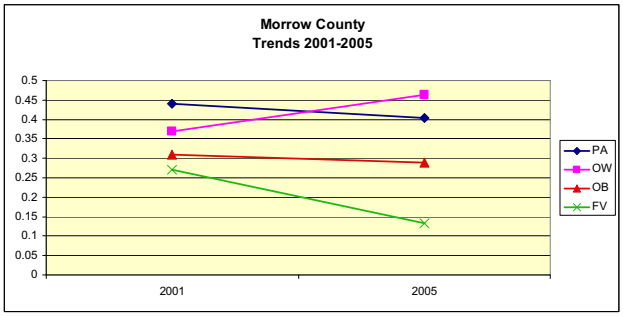
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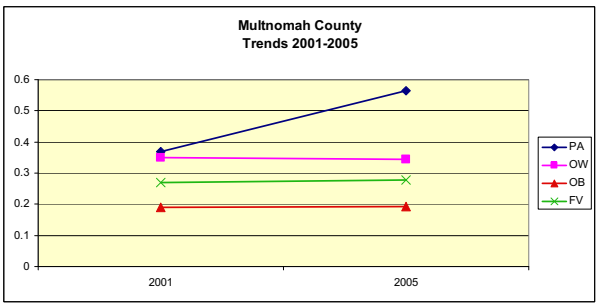
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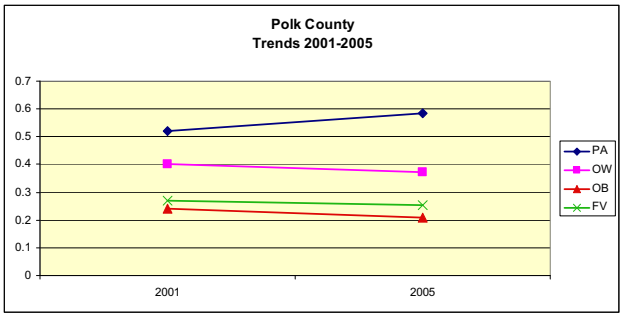
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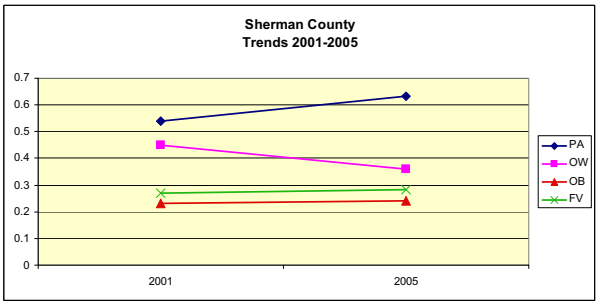
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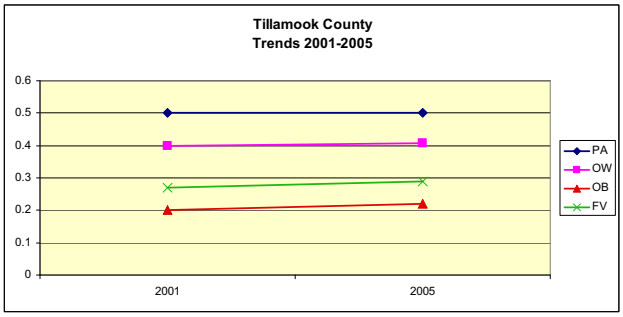
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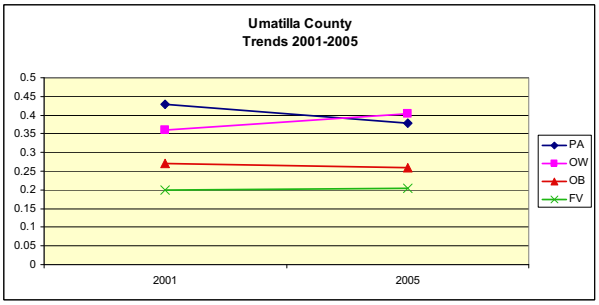
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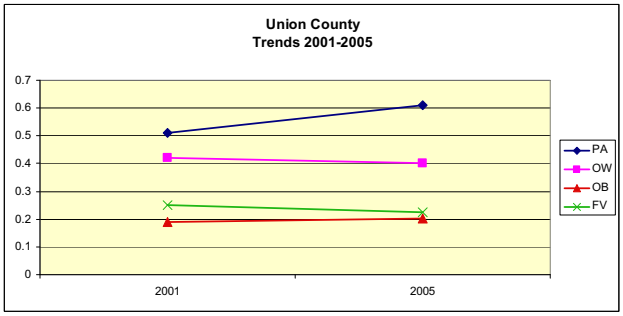
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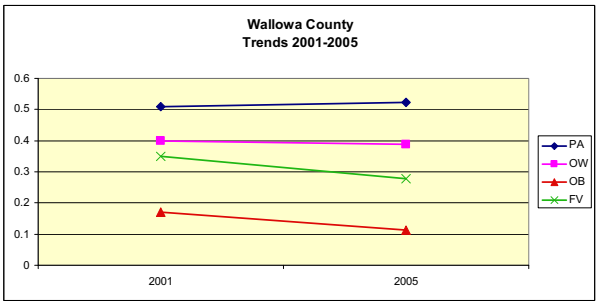
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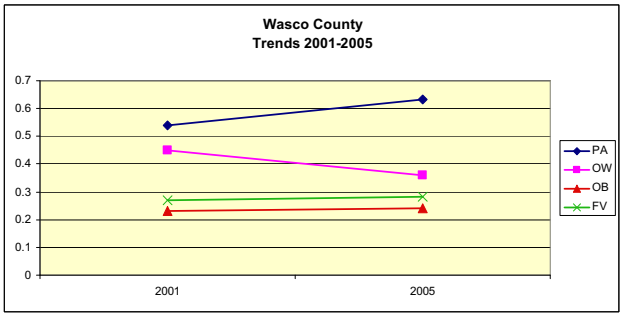
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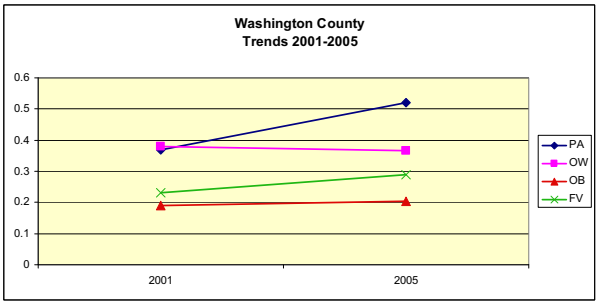
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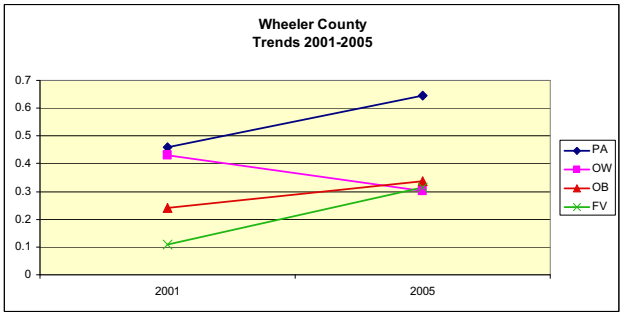
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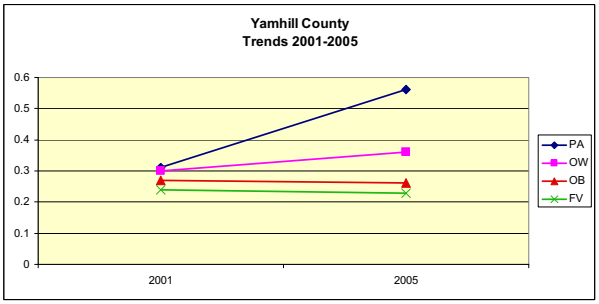
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FV

APPENDIX D: Pairwise Correlation Tests

Table D1. Pairwise Correlations with Health Prevalence Indicators, Oregon (n=36).

Variable	Physical Activity (%)	Overweight (%)	Obese (%)
HEALTH INDICATORS			
Physical Activity (%)	X	0.55**	---
Overweight (%)	0.55**	X	---
Obese (%)	---	---	X
DEMOGRAPHICS			
Population, Total	-0.45**	-0.35*	---
Age, Median	0.31	0.37*	---
Population, 18-24 (%)	---	-0.44**	---
Population, 25-44 (%)	-0.38*	-0.34*	---
Population, 45-64 (%)	0.36	0.33	---
Income, Per capita	---	-0.30	-0.41*
Household density, households per acre	-0.31	-0.28	---
Population, White (%)	---	---	-0.32
Population, Latino (%)	---	---	0.31
Population, Black (%)	-0.29	-0.31	---
Population, Native American (%)	---	---	0.46**
Population, Asian (%)	-0.33	-0.28	-0.37*
College, %25+ with bachelor's degree	---	-0.28	-0.54**
COUNTY CLASSIFICATION			
Metro	---	-0.50**	---
Urban	---	---	0.29
Rural	0.30	0.34*	---
RECREATION SUPPLY & DEMAND			
Facilities[a], per household	0.27	0.49**	---
Public Acres, % county	---	---	-0.36*
Federal Acres, % county	---	---	-0.35*
State Acres, % county	---	---	---
Municipal Acres, % county	-0.28	-0.32	---
Water Acres, % county	---	-0.32	---
Urban Trails[b], miles per household	0.35*	---	---
Hiking Trails[c], miles per household	0.34*	---	---
Hiking, Days per household per year	---	---	-0.28
Hiking, % participating	---	---	-0.36*
Urban trails, % participating	----	-0.34	---
Sports, % participating	-0.14*	-0.28	---

All significant at 0.10 level; * at 0.05 level; ** at 0.01 level.

[a]Facilities includes the number of baseball/softball fields; football/rugby/soccer fields; indoor and outdoor swimming pools; outdoor basketball nets; outdoor tennis courts; public and private golf courses; miscellaneous recreation centers; and baseball batting cages.

[b]Urban Trails includes miles of surfaced and unsurfaced bike trails; surfaced and unsurfaced community walking paths; and surfaced and unsurfaced jogging trails.

[c]Hiking Trails includes miles of surfaced and unsurfaced hiking trails.

Table D2. Pairwise Correlations with County Classifications, Oregon (n=36).

Variable	Metro	Household Density (HH/acre)	Rural
DEMOGRAPHICS			
Population, Total	0.67**	0.86**	---
Age, Median	-0.52**	-0.31	0.45**
Population, 18-24 (%)	0.54**	---	-0.44**
Population, 25-44 (%)	0.58**	0.63**	-0.40*
Population, 45-64 (%)	-0.45**	-0.33	0.45**
Income, Per capita	0.76**	0.53**	---
Household density, households per acre	0.46**	X	---
Population, White (%)	---	-0.32	0.36*
Population, Latino (%)	---	---	-0.28
Population, Black (%)	0.39*	0.94**	---
Population, Asian (%)	0.58**	0.77**	---
Population, Pacific Islander (%)	0.28	0.40*	-0.42*
College, %25+ with bachelor's degree	0.68**	0.46**	---
Commute Time, to work, mean minutes	0.45**	0.29	---
RECREATION SUPPLY & DEMAND			
Facilities[a], per household	-0.31*	---	0.76**
Municipal Acres, % county	0.27	0.62**	---
Water Acres, % county	---	0.52**	---
Urban Trails[b], miles per household	---	---	0.52**
Hiking Trails[c], miles per household	-0.33*	---	0.62**
Hiking, % participating	0.51**	---	---
Urban trails, % participating	0.65**	0.32	-0.39
Sports, % participating	0.56**	0.38*	---

All significant at 0.10 level; * at 0.05 level; ** at 0.01 level.

[a]Facilities includes the number of baseball/softball fields; football/rugby/soccer fields; indoor and outdoor swimming pools; outdoor basketball nets; outdoor tennis courts; public and private golf courses; miscellaneous recreation centers; and baseball batting cages.

[b]Urban Trails includes miles of surfaced and unsurfaced bike trails; surfaced and unsurfaced community walking paths; and surfaced and unsurfaced jogging trails.

[c]Hiking Trails includes miles of surfaced and unsurfaced hiking trails.

Table D3. Pairwise Correlations with Recreation Supply Measures, Oregon (n=36).

Variable	Facilities[a]	Urban Trails[b]	Hiking Trails[c]
Facilities[a], number	X	0.78**	---
Urban Trails[b], miles	0.78**	X	0.47**
Hiking Trails[c], miles	---	0.47**	X
Physical Activity (%)	-0.50**	-0.35**	---
Overweight (%)	-0.34*	-0.43**	---
Metro	0.68**	0.52**	---
Rural	-0.28	---	---
Household density, households per acre	0.72**	0.63**	---
Public Acres, % county	---	---	0.44**
Federal Acres, % county	---	---	0.55**
Municipal Acres, % county	0.32	---	---
Water Acres, % county	---	0.32	---
Hiking, Days per household per year	-0.30	---	---
Hiking, % participating	---	0.29	---
Urban trails, % participating	0.44**	---	---
Sports, % participating	0.55**	0.29	---

All significant at 0.10 level; * at 0.05 level; ** at 0.01 level.

[a]Facilities includes the number of baseball/softball fields; football/rugby/soccer fields; indoor and outdoor swimming pools; outdoor basketball nets; outdoor tennis courts; public and private golf courses; miscellaneous recreation centers; and baseball batting cages.

[b]Urban Trails includes miles of surfaced and unsurfaced bike trails; surfaced and unsurfaced community walking paths; and surfaced and unsurfaced jogging trails.

[c]Hiking Trails includes miles of surfaced and unsurfaced hiking trails.

APPENDIX E: Simultaneity Tests

Relationship	Test	Coefficient	p-value
$OB = f(\hat{P}A)$	Hausman	-0.08	0.36
	Pindyck & Rubinfeld	-1.26	0.01
$OW = f(\hat{P}A)$	Hausman	0.26	0.01
	Pindyck & Rubinfeld	0.16	0.39
$PA = f(\hat{O}B)$	Hausman	-0.12	0.73
	Pindyck & Rubinfeld	-0.74	0.22
$OW = f(\hat{O}B)$	Hausman	-0.20	0.20
	Pindyck & Rubinfeld	0.14	0.54
$PA = f(\hat{O}W)$	Hausman	1.25	0.01
	Pindyck & Rubinfeld	2.13	0.03
$OB = f(\hat{O}W)$	Hausman	-0.33	0.22
	Pindyck & Rubinfeld	0.08	0.88

APPENDIX F: Spatial Dependence Tests

Test	PA Model	OW Model	OB Model
Moran-I	-0.111	0.048	-0.132
LM error	0.968 (17.611)	0.178 (17.611)	1.360 (17.611)
LR test	1.536 (6.635)	0.294 (6.635)	7.743 (6.635)
Wald test	2.811 (6.635)	0.211 (6.635)	75.663 (6.635)
LM error in SAR model	3.933 (6.635)	2.336 (6.635)	6.200 (6.635)

Critical value in parentheses.

APPENDIX G. Maps of Recreation Supply and Demand in Oregon, 2001-2002. (Source OPRD 2001, 2003)

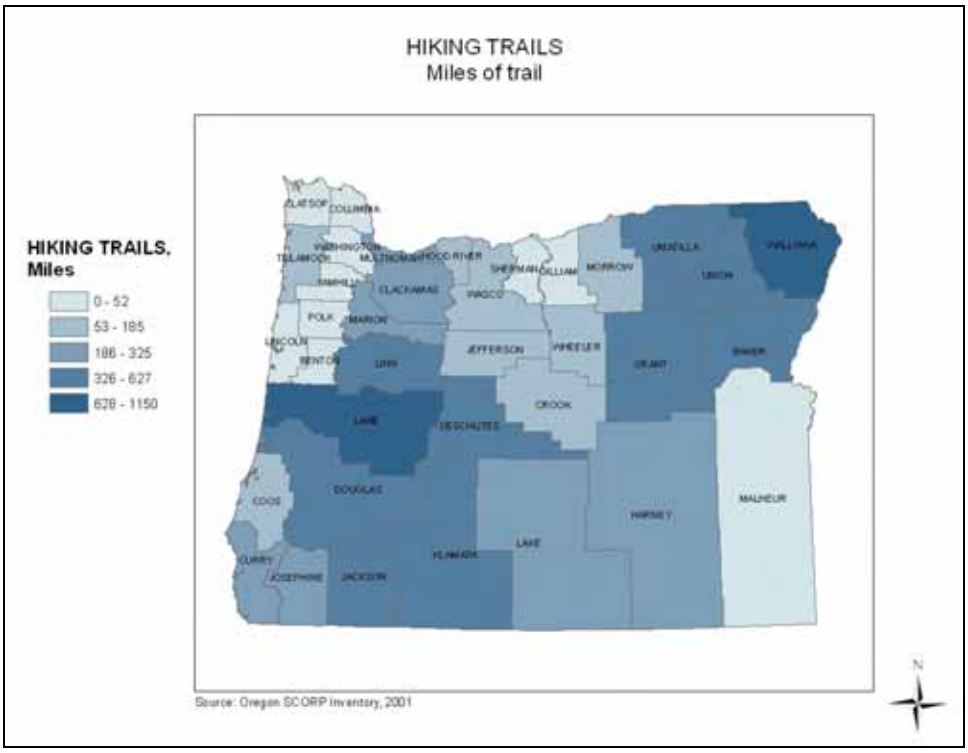

Figure G1. Miles of hiking trails.

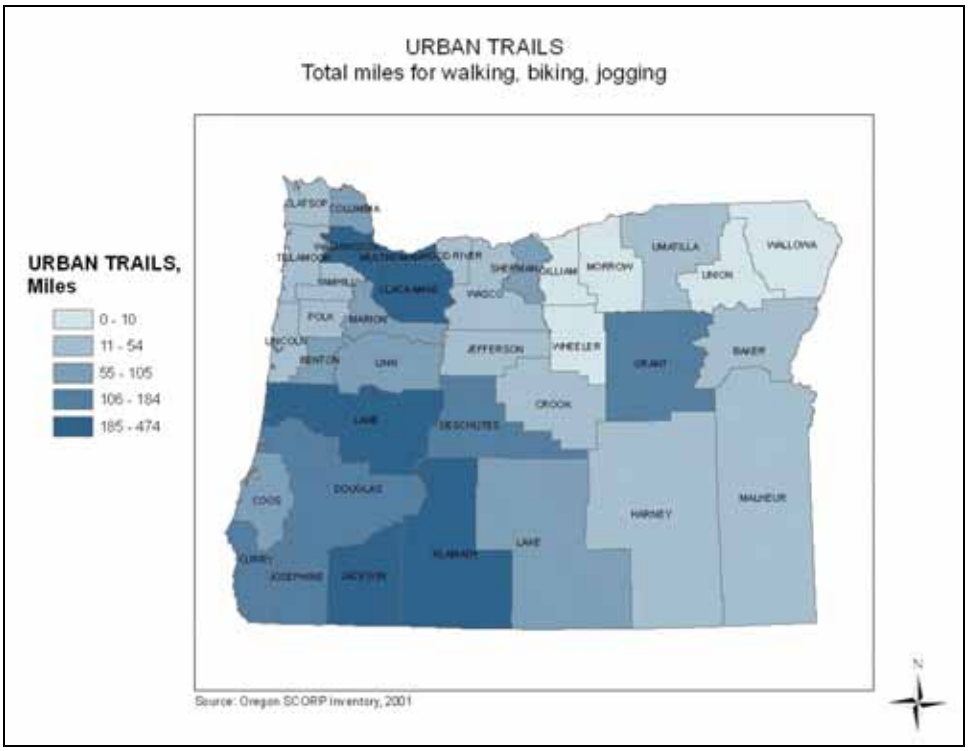

Figure G2. Miles of urban trails.

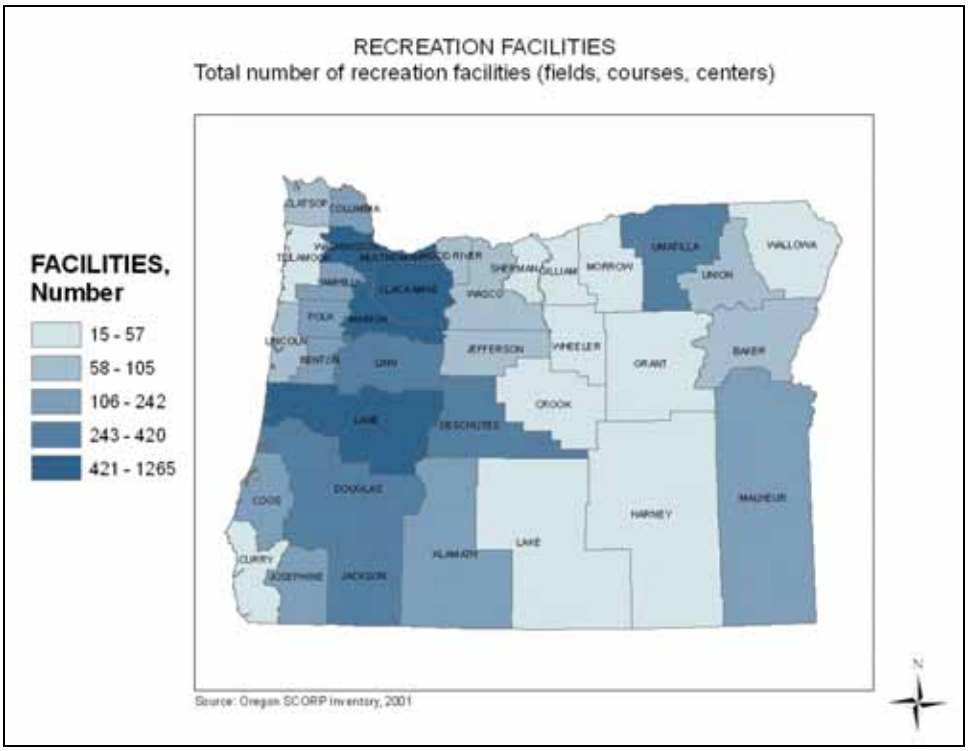

Figure G3. Total number of recreation facilities.

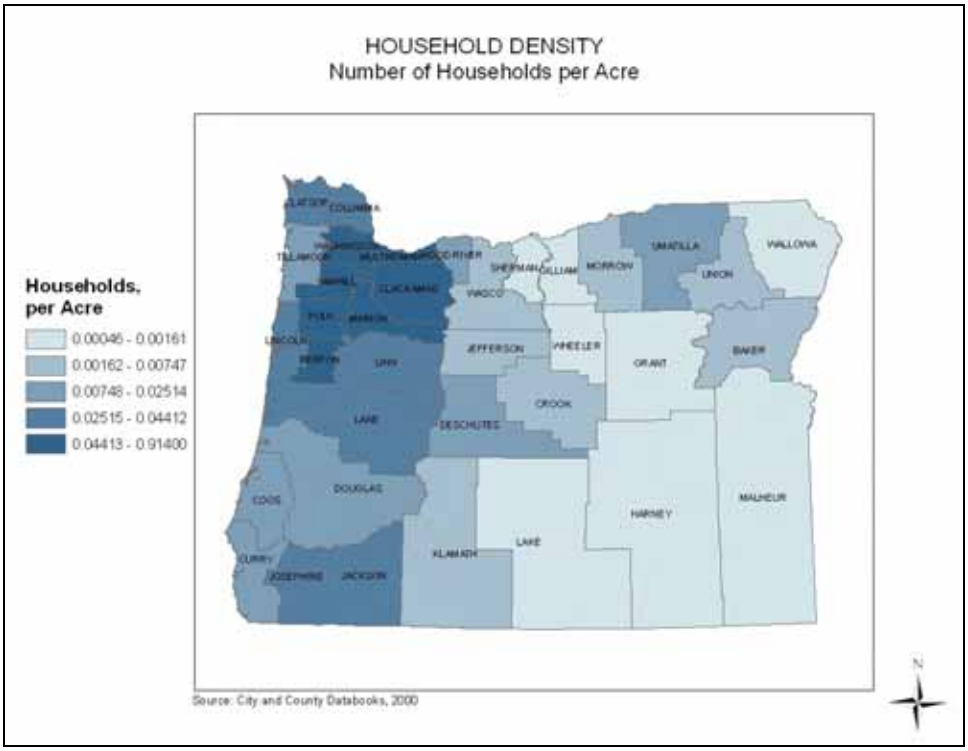

Figure G4. Household density (number of households per acre).

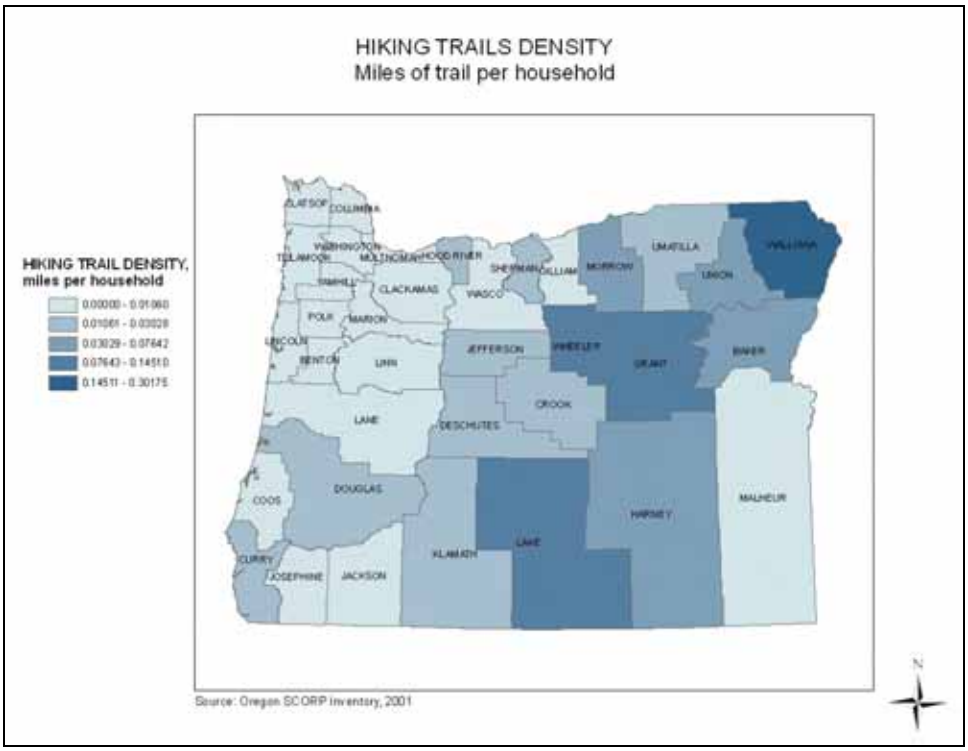

Figure G5. Hiking trail miles density (miles of trail per household).

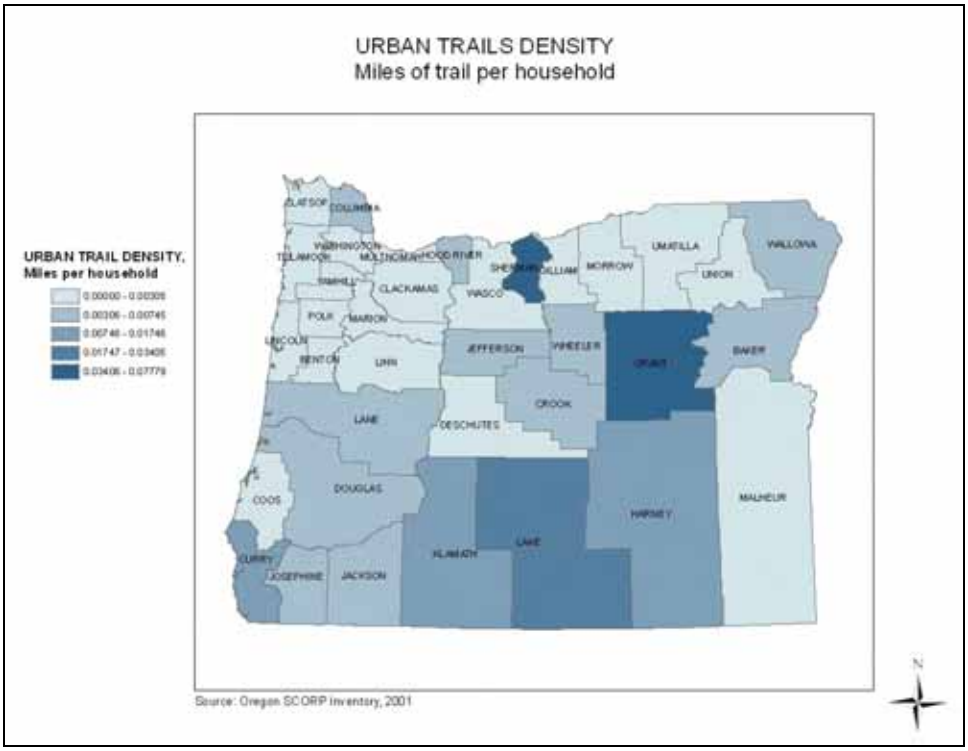

Figure G6. Urban trail miles density (miles of trail per household).

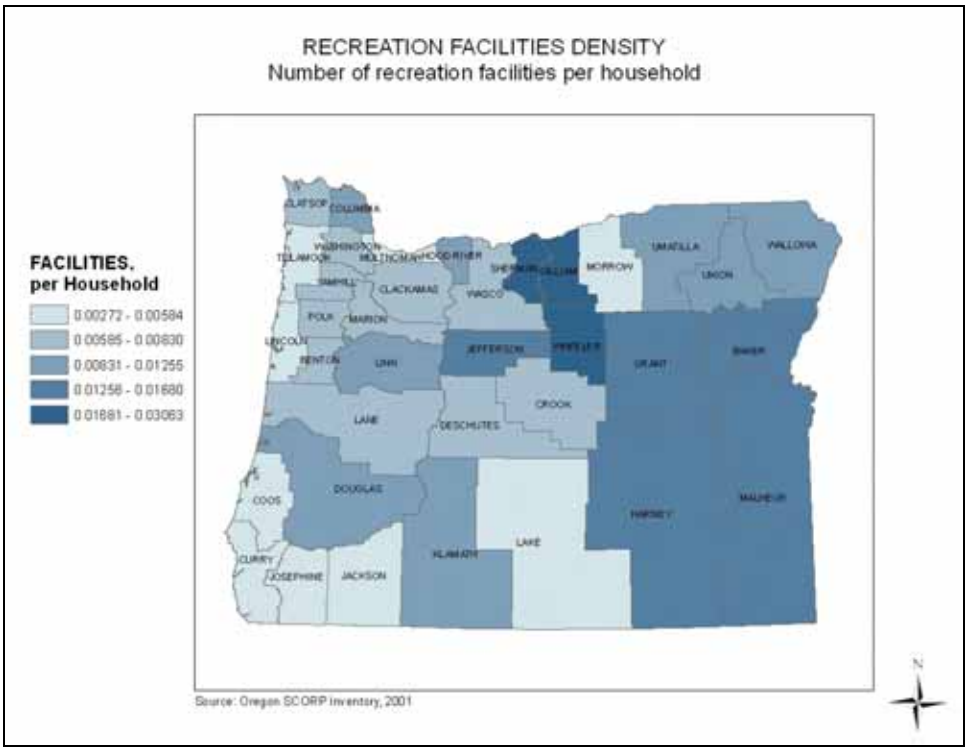

Figure G7. Recreation facilities density (number of facilities per household).

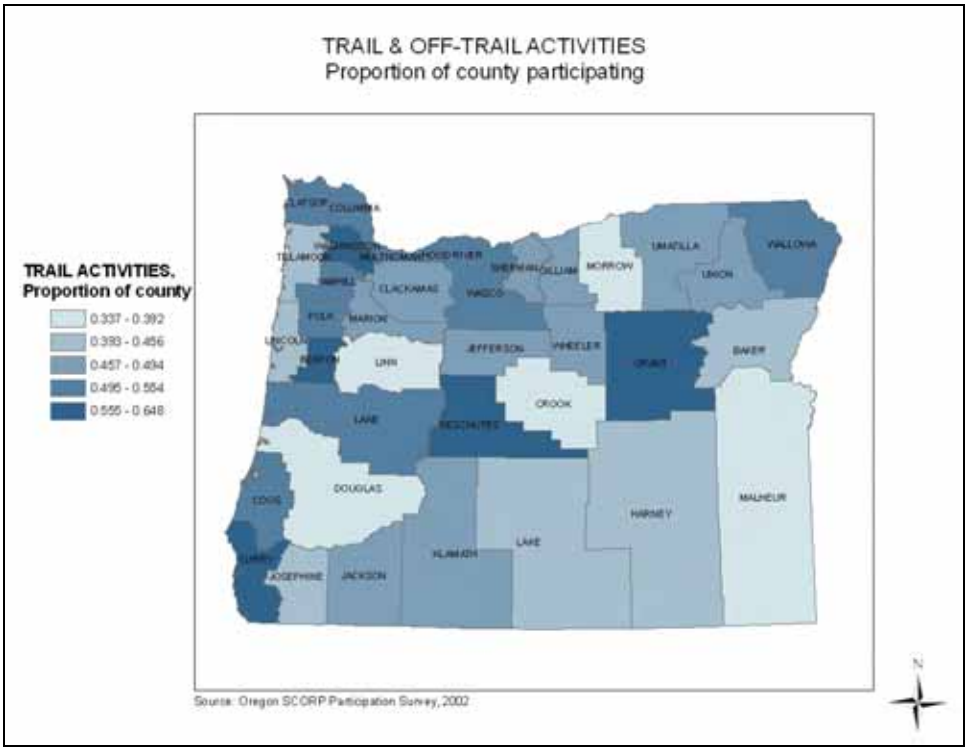

Figure G8. Proportion participating in trail or off-trail activities.

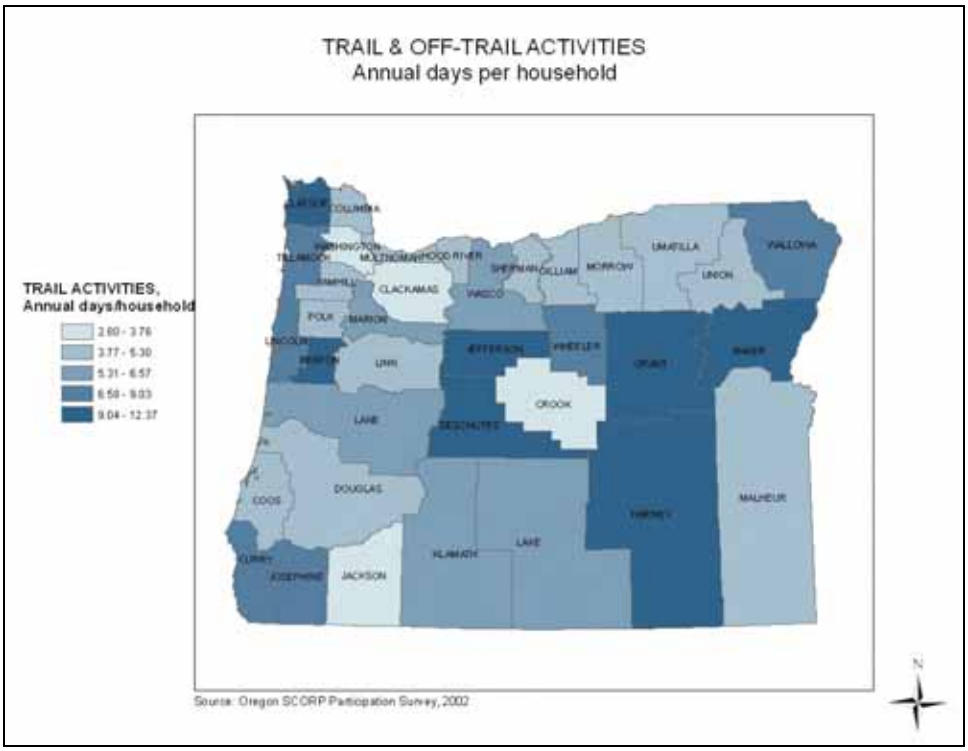

Figure G9. Average annual days per household in trail or off-trail activities.

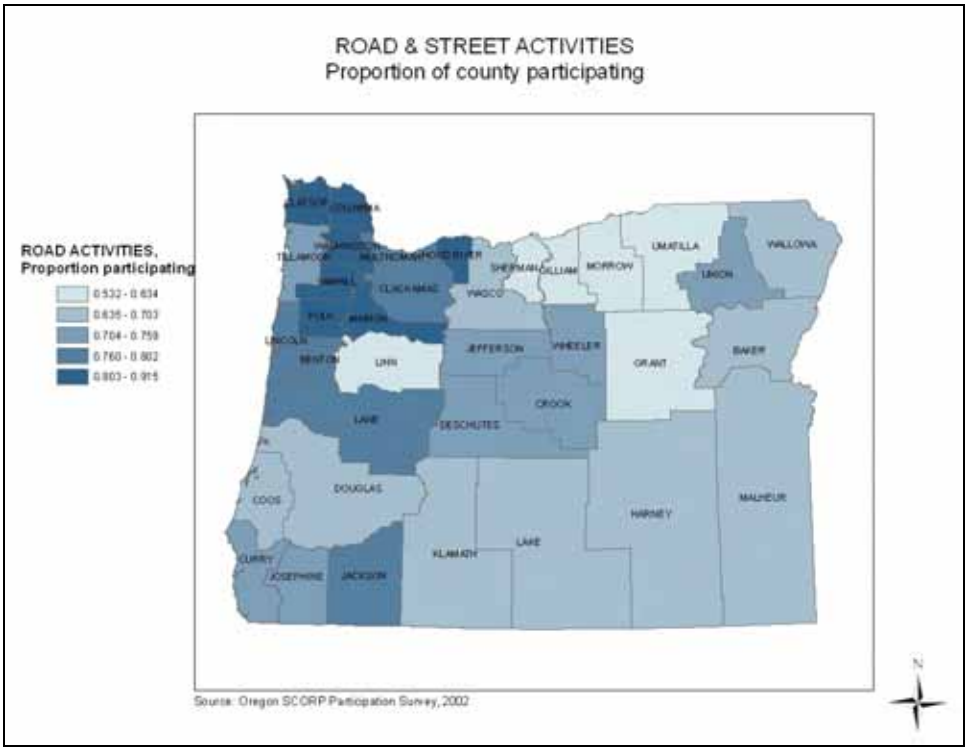

Figure G10. Proportion participating in road and street activities.

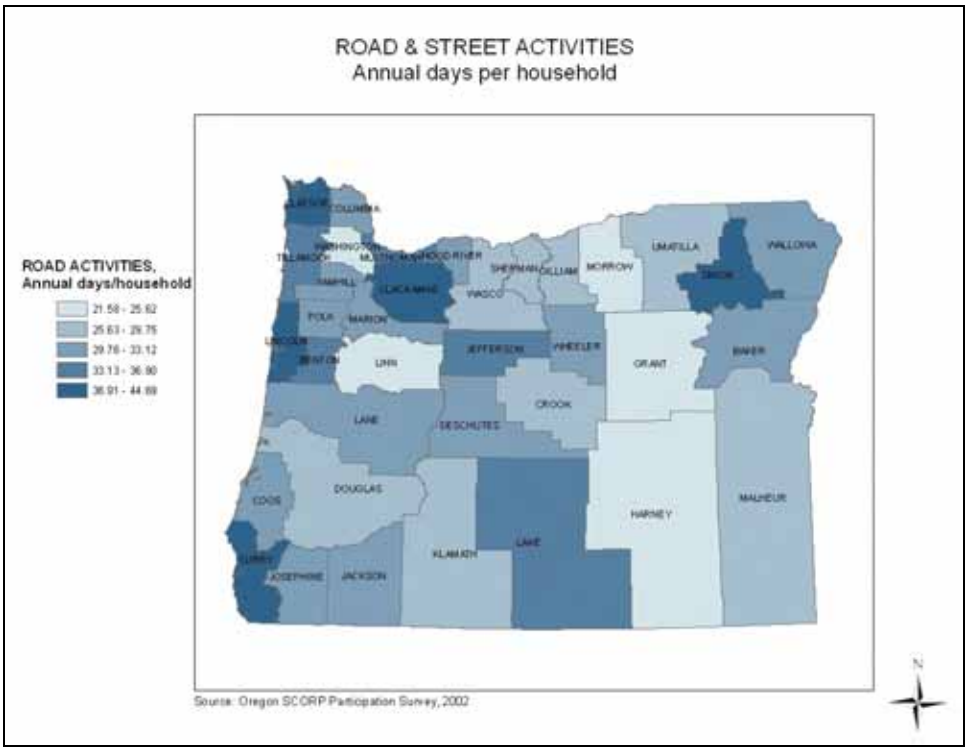

Figure G11. Average annual days per household in road and street activities.

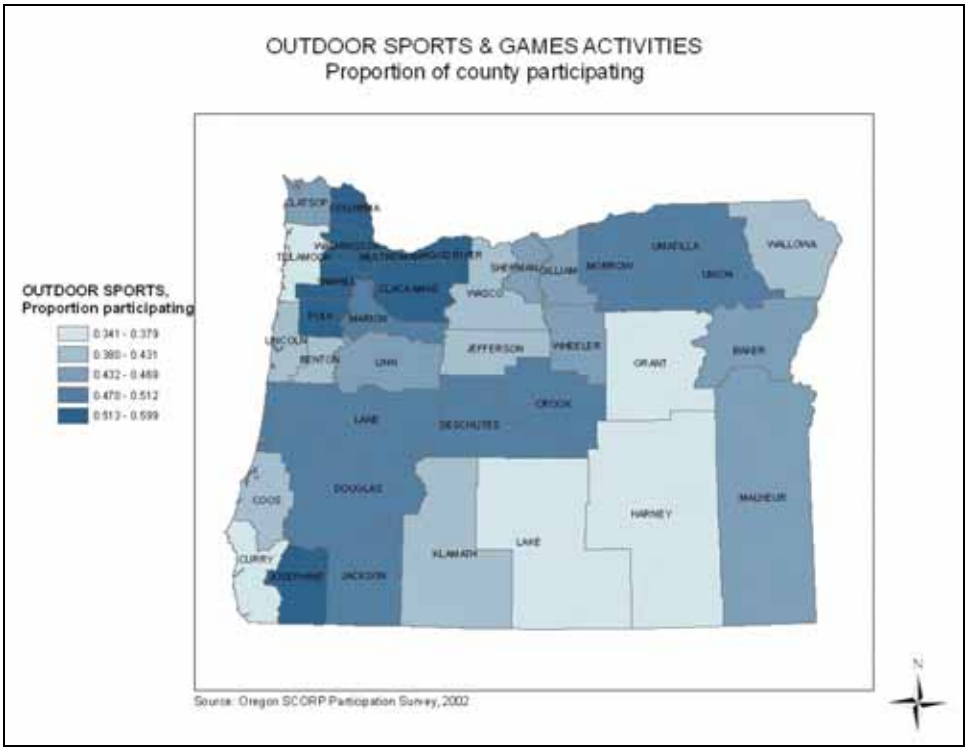

Figure G12. Proportion participating in outdoor sports and games activities.

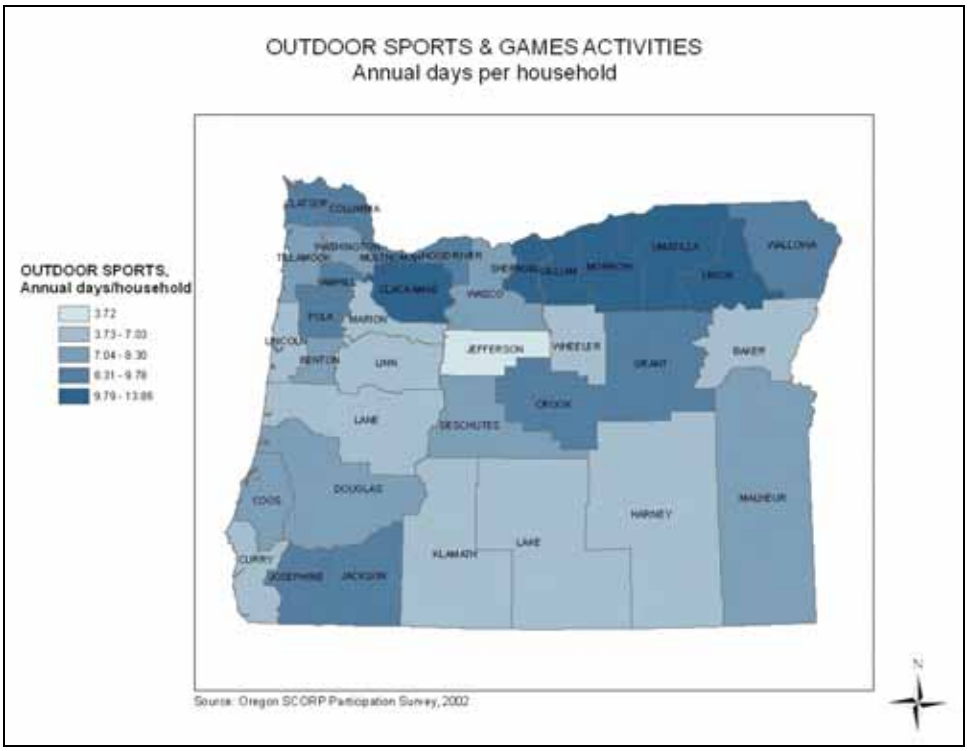

Figure G13. Average annual days per household in outdoor sports and games activities.