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Promoting Campus Cycling for Outdoor Recreation and Transportation: Investigating Factors Influencing Student Bicycle Usage on a Large, Southeastern University from an Ecological Perspective

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Abstract

Biking is a popular recreational activity, and understanding how to promote participation is important to college health and recreation professionals. The purpose of this study was to examine factors contributing to cycling behaviors on one large college campus from an ecological perspective. Students were surveyed at a southeastern university in 2014 (n = 3 56). The survey instrument included intrapersonal, interpersonal, and institutional predictors of cycling practices. The predictors of cycling engagement included gender, ethnicity, and race and also intrapersonal and interpersonal variables that predispose participation. This inquiry was intended to offer insights to guide the planning and implementation of targeted, multilevel cycling promotion programming for the campus community to increase commuting options and create opportunities for outdoor recreation involving bicycling. This study identified factors that facilitate or hinder university campus cycling as well as demographic predictors of cycling behavior.

KEYWORDS: college health; environmental health; cycling; bikeability; social ecological model

Background

Cycling refers to a human propelled one-, two-, or three-wheeled cycle used to exercise, enjoy leisure, or commute ("Cycling," 1989). It is a popular recreational activity, it is an effective method for increasing individual physical activity levels, it promotes environmental health, and it can be cost effective (Cavill & Davis, 2003; Oja et al., 1991; Vuori, Oja, & Paronen, 1994; Woodcock, Edwards, & Tonne, 2009). For instance, cycling for active transportation or leisure has been found to offer a low-impact movement option that reduces the risk factors of diseases such as type 2 diabetes (Albert, 1999; Wannamethee, Shaper, & Alberti, 2000). Cycling is associated with individual health benefits such as heart health and lowered BMI, even when it is not the sole mode of transportation; protective effects of cycling behaviors remain, even when it is combined with use of local transportation systems (Oja, Vuori, & Paronen, 1998).

As a form of outdoor recreation, cycling is popular across age demographics, but it is uniquely influenced by environmental considerations commonly referred to as the "bikeability" of an environment (Romsa & Hoffman, 1980). In general, outdoor recreation participation is strongly related to attitudes toward specific aspects of the environment necessary for pursuing a given activity (Jackson, 1986). The need to approach promotion of cycling from an ecological perspective considering multiple influences on the behavior is paramount (Paracchini et al., 2014). Personal attitudes and beliefs, social norms, and the built environment contribute to cycling as an outdoor recreational choice on college campuses, and an ecological approach to assessing bikeability is indicated in the literature (Degenhardt, Frick, Buchecker, & Gutscher, 2011). There is a significant gap in the literature in the area of ecological bikeability assessments on university campuses that rely on theoretical frameworks instead of an ecological perspective (Bopp, Kaczynski, & Wittman, 2011; Sisson & Tudor-Locke, 2008).

Whether participants bike for leisure or transport, route accessibility is an important consideration. Many states, cities, and college campuses across the United States encourage a bicycle friendly atmosphere (Shinkle & Teigen, 2008) because cycling affects the physical, psychological, and environmental health of university students (Cavill & Davis, 2003; Kaczynski, Bopp, & Wittman, 2010; Rybarczyk & Gallagher, 2014). High levels of bicycle usage is an advantage for any campus community, as students are healthier, save money, and decrease health care costs (Davis, 2010). For these reasons, one of the objectives of Healthy People 2020 is to increase trips to work made via cycling by 10% (U.S. Department of Health and Human Services, 2014).

Cycling as a method of transportation improves the health of individual cyclists, and it also helps mitigate climate change and improves environmental health (Macmillan et al., 2014). Bicycle commuting offers a nonpolluting, noncongesting physically active form of transportation (Mapes, 2009). Cycling has been found to be beneficial to university campuses, especially for issues pertaining to student population increases and inadequate parking areas or transportation systems (Arnott & Inci, 2006; Balsas, 2003; Shang, Lin, & Huang, 2007). Cycling helps reduce the amount of motor vehicles on the road and affects vehicular parking needs (Jacobsen, 2003). Because 40% of trips in the United States are within 2 miles of a person's home, cycling is an adequate transportation choice for such trips and can easily replace motor vehicle transportation (Mapes, 2009).

Cycling also offers financial benefit at societal, institutional, and individual levels that offer important reasons to advocate for cycling (Davis, 2010). According to the Office of the Federal Environmental Executive, bicycling commuting decreases work absenteeism, increases employee productivity, and reduces transportation maintenance costs (Pucher, Dill, & Handy, 2010). Commuting via bike does not require a person to fill up on gas, requires less space than a motorized counterpart, and causes little wear on the roads. For these reasons, cycling is an inexpensive and sustainable form of transport (Gatersleben & Appleton, 2007). Because cycling is a relatively low-cost transportation option that offers personal and environmental benefits, cycling promotion can be beneficial on college campuses. Outdoor recreation programs looking to promote cycling for transport and for leisure can promote an active living agenda by approaching the issue in multilevel fashion (Godbey, Caldwell, Floyd, & Payne, 2005).

According to the American Community Survey, from 2000 to 2008 bicycle commuting increased 43%. However, less than 1% (approximately 0.55%) used cycling as their predominant form of transportation (U.S. Census Bureau, 2010). Many cities rarely exceed 5%, even though cities such as Minneapolis once had a bicycle population that made up over 20% of its normal downtown traffic (Mapes, 2009). Among college students, 53.7% claimed to have ridden a bicycle in the last 12 months, which is above the national average (American College Health Association, 2015). Large schools, in particular, such as the University of Alabama, can benefit from bikeability efforts. According the University of Alabama, the campus population has grown by nearly 15,000 students from 2004 (enrollment, 20,969) to 2015 (enrollment, 34,852). Commuters to campus are challenged to find adequate parking and need to take another form of transportation to specific buildings or classes, whereas students who live on campus have specific parking hubs (Roff, 2003; University of Alabama, 2015a, 2015b).

Despite the benefits of cycling, the risk of being injured on the road or involved in a vehicular accident exists for cyclists (Albert, 1999; Bentley & Page, 2008). In part this is due to modern traffic systems that are designed for compatibility with automobiles rather than with bicycles (Wegman, Zhang, & Dijkstra, 2012). As a result, people in the United States cycle less than people in any other country. Other factors associated with low cycling rates include the lack of bike lanes and the need for cyclists and motor vehicles to share the road (Wegman et al., 2012). Even when bicycle paths and lanes are available, many cyclists do not use them, because of poor construction or deterioration of the lanes or a perceived, self-reported lack of convenience.

A lack of a bike lane is an environmental barrier affecting cyclists' perceptions of personal safety and contributes to lower rates of participation (Jacobsen, 2003). Such participation is an important consideration because health behaviors (specifically physical activity practices) in young people become habits for adults, and the college environment plays an important role in affecting the current and future health behaviors of university students (Bopp et al., 2011; Strathman, Gleicher, Boninger, & Edwards, 1994). A bike-friendly campus increases the likelihood that students will engage in the activity for leisure or travel to class (Kaczynski et al., 2010). This creates a positive feedback cycle, because increasing the number of cyclists has been found to increase the rates of perceived safety in the population (Jacobsen, 2003).

The purpose of this study was to examine college students' perceptions of safety and factors contributing to campus cycling from an ecological perspective, with a focus on individual attitudes, social norms, and environmental barriers or supports to cycling practice. The Social Ecological Model provides a framework for understanding human behavior (or pattern of disease or injury) and the ways it interacts with the social and physical environments (Bronfenbrenner, 1979). The model postulates that human behavior is influenced by multiple factors that occur at various levels of influence: intrapersonal, interpersonal, community, institutional, and policy (Sallis et al., 2006; Stokols, 2000). In this study, intrapersonal, interpersonal, and institutional factors associated with campus cycling were assessed, as well as how these influences interact with each other. This framework, combined with direct student recommendations for improving cycling, can be used to inform health promotion efforts on campus.

Method

Research Design and Data Collection

A nonexperimental, cross-sectional study design was used, and data were collected using online surveys. The researchers interviewed University of Alabama undergraduate and graduate students, with inclusion criteria requiring that participants be a current student at the graduate or undergraduate level, be between ages 17 and 24 years old, and have the ability to read and write English.

Recruitment took place between November and December 2014 through various classes on the campus. Convenience sampling was conducted primarily through class presentations in the departments of Health Education, Interdisciplinary Studies, and Social Work. Electronic invitations to participate were disseminated to classes in exercise science, communication, business, and rural health. Some sampling occurred as a result of personal requests. Approximately 1,000 students were invited to participate in the study without incentive, from 30 classes with 20–60 students/class.

Institutional review board approval was obtained from the University of Alabama. The research questions explored in the study included the following: (1) Of the student sample, what is the prevalence of on-campus cycling at the university? (2) How does cycling differ between student subgroups? (3) Which intrapersonal, interpersonal, and institutional factors facilitate or hinder cycling at the university?

Cycling Survey Development

Often, an already existing single instrument has not yet been developed and validated for the purposes of a given study; modifications relying on validated instruments are useful for tailoring an instrument to a specific study in such cases (Snyder, Watson, Jackson, Cella, & Halyard, 2007). To address the research questions, the research team developed an instrument by supplementing three already existing questionnaires with additional scales or questions. As such, use of this instrument was exploratory and pilot in nature. The survey developed for the study, Cycling Survey for the University of Alabama, was initially based on items from (1) the National Highway Traffic Safety Administration's Bikeability Checklist (U.S. Department of Transportation, 2013), (2) the University of California at Davis' Travel Survey (Driller, 2013), and (3) the California State University at Channel Islands' (2012) Bike Transportation Survey. These reliable, validated instruments have been used to assess bikeability and active transport in communities and on campuses with similar sample demographics (California State University at Channel Islands, 2012; Lowry, Callister, Gresham, & Moore, 2012; Miller, 2011).

Initial survey questions were made available to participants via Qualtrics, and answer options included either a 5-point Likert scale or "Check all that apply" format to collect accurate information. Additional survey items were added based on a pilot study consisting of qualitative interviews conducted with the University of Alabama's Bike Advisory Group (n = 20) and students (n = 5). The advisory group consisted of stakeholders invested in the growth and safety of campus cycling and included personnel from campus planning, student residence, recreation, university police, university parking, and financial affairs. During this constructive phase, the survey instrument was assessed for appropriate terminology, literacy level, flow of questions, duration, and any unnecessary or missing items relevant to the study.

Cycling Survey Variables

The resulting instrument contained 65 survey items (approximately 15-min completion duration) and assessed student demographics, cycling behaviors, perceptions of cycling, cycling safety issues, and barriers/facilitators of cycling. These variables were categorized according to an evaluated level of the Social Ecological Model.

Intrapersonal-level factors. Intrapersonal factors were grouped into three categories: personal safety factors, bike-specific issues, and appearance. Intrapersonal survey items that pertained to personal safety issues included statements such as "The weather is not suitable," "I have personal safety/security concerns," I don't like to riding after dark," "I had an accident or scare/near-miss on a bike in the past," and "I don't know cycling rules."

Intrapersonal survey items that pertained to bike-specific issues included statements such as "I wish I knew more about general bike maintenance," "I don't know how to work the gears," "I can never get my brakes working right," and "I'm not confident in using a bike lock."

Intrapersonal survey items that pertained to appearance issues included statements such as "I feel or look silly on a bike," "Helmets mess up my hair," and "Other cyclists look fit and I don't."

Interpersonal-level factors. Interpersonal cycling factors on the survey addressed perceptions regarding participants' interaction with traffic and drivers. The survey items pertained to statements such as "distracted drivers," "motorists who run red lights and stop signs," "crossing at intersections," and "volume of motor vehicles."

Institutional-level factors. Institutional factors included factors of the built environment that encourage or inhibit students from cycling. Survey items that pertained to institutional factors included statements that assessed barriers to cycling such as "there are inadequate bike lanes or bike paths in my area" and "there is no place to change my clothes after cycling to campus." Institutional factors on the survey that were considered facilitators included items such as "covered parking," "locker/shower facilities," "better markings/signage," and "more connectivity to downtown/shopping."

Data Analysis

Descriptive statistics, including frequencies and chi-square results, were generated from the data analysis. Based on preliminary analyses, a series of univariate and multivariate logistic regressions were used to analyze the data and compare relationships between students who cycled and those who did not. The a priori was set at less than or equal to .05. Data analysis was conducted using the SPSS 21 for Macintosh in coordination with Qualtrics automatic conversion.

Results

Sociodemographic Characteristics and Cycling

The analyzed sample consisted of 356 participants. The sample for the study was comparable to actual campus statistics in the following categories: student level (undergraduate/graduate), gender, race, ethnicity, and junior level of education. The student demographic at the surveyed campus site was 45% male, 12% African American, and 2% Asian American. Undergraduates made up 84% of the student population, with 29% freshmen, 22% sophomore, 22% juniors, and 24% seniors (University of Alabama, 2015a, 2015b).

Frequencies and descriptive statistics highlighted the prevalence of on-campus cycling. Of the respondents, 28.1% responded that they owned or rented a bike on the campus, n = 100, CI [23.4, 32.8]. The results indicated that cycling was used for school (85.0%), exercise (43.0%), and work purposes (31.0%). Nearly two thirds of cyclists reported they had cycled within the last week. A little over one half (53%) said they cycled exclusively or that they never combined cycling with other modes of transportation.

Of particular importance for health professionals considering program prioritization are the variables demonstrating high levels of practical significance. To provide macro-level practical significance information, crosstab analysis was used to check for the practical significance of independent variables on dependent variables (Hosmer & Lemeshow, 2000). Significance levels were set a priori at $p < .05$ (Chatterjee & Simonoff, 2013; Young, Turner, Denny, & Young, 2004). Over half of the students were 21–22 years of age (54.4%) and 76.1% of the population described themselves as White/non-Hispanic (Table 1). Of the respondents, 73.9% were female. In the overall subsample of female participants, 23.6% owned or rented a bike on campus compared to 40.9% of the total male subsample (Table 1). This relationship was statistically and practically significant. Gender had an effect on the likelihood of cycling (OR = 2.24). Male participants were approximately twice as likely to cycle as their female counterparts.

Race/ethnicity was statistically significant (p = .009). The White/non-Hispanic participants were 5 times more likely than the non-Hispanic Black participants to cycle, CI [1.66, 11.22]. All other races were 4 times more likely than non-Hispanic Black participants to cycle, CI [1.55, 16.28].

Table 1
Cyclist Demographics (n = 100)

Variable	*n*	% of total variable cycling
Gender		
Male	38	40.9
Female	62	23.6
Age		
18	8	40.0
19	12	33.3
20	25	35.7
21	28	23.7
22	17	22.4
23	6	26.1
24	4	30.8
Race/Ethnicity		
White/Non-Hispanic	84	31.0
Black/African American	5	9.4
Other	11	34.4
University Status		
Undergraduate	93	28.0
Graduate	7	29.2
Year in College		
Freshmen	8	36.4
Sophomore	11	29.7
Junior	25	27.5
Senior	51	26.7
Colleges		
College of Arts & Sciences	19	33.3
Culverhouse College of Commerce	12	33.3
College of Communication & Information Sciences	19	27.1
College of Education	8	18.6
College of Engineering	14	60.9
College of Human Environmental Sciences	15	18.1
Capstone College of Nursing	0	0.0
School of Social Work	1	50.0

A multivariate logistic regression was performed to ascertain the effects of gender, age, and race/ethnicity on the likelihood that participants are cyclists. Significance was found in gender ($p \leq .001$), non-Hispanic White participants ($p = .002$), other combined racial/ethnic groups, and age ($p = .034$). The logistic regression model explained 11.5% of the variance in cycling.

Intrapersonal Factors and Cycling

Intrapersonal factors were compared between cyclists and noncyclists for personal safety factors, bike-specific issues, and appearance. Chi-square analysis was performed on all of the intrapersonal cycling factors, including personal safety, bike-specific issues, and appearance factors. Of these, 14 intrapersonal factors were statistically significant (Table 2). For example, "weather" was a significant personal safety barrier ($p \leq .001$), "knowing how to carry books or cargo while cycling" was a significant bike-specific factor ($p \leq .001$), and "feeling silly while cycling" was a significant appearance-related factor ($p \leq .001$).

When all of the personal safety factors were analyzed as a single grouped factor, the result was not statistically significant. Therefore, as a whole, personal safety factors were not an important predictor of cycling ($p = .997$). However, when combined with significant personal appearance factors ($p = .006$), bike-specific issues were statistically significant ($p \leq .001$).

Table 2
Intrapersonal Cycling Factors

	Cyclist (n = 100)		Noncyclists (n = 256)	
Question	***n***	**%**	***n***	**%**
Personal Safety Factors				
What factors influence your cycling decisions?				
I don't know how to ride a bike.	0	0.0	16	2.8
The distance is too far.	29	29.0	79	30.9
The weather is not suitable.	56	56.0	53	20.7
I have personal safety/security concerns.	16	16.0	42	16.4
I don't know cycling rules.	5	5.0	41	16.0
My cycling skills are poor.	2	2.0	37	14.5
I can't afford a bicycle.	1	1.0	29	11.3
I'm not in shape to ride a bicycle.	2	2.0	12	4.7
I'm concerned about aggressive/distracted drivers.	43	43.0	81	31.6
I don't like being assertive with drivers.	10	10.0	32	12.5
I don't like to ride after dark.	30	30.0	67	26.2
I had an accident or scare/near-miss on a bike in the past.	13	13.0	16	6.3
I don't like riding close to traffic.	22	22.0	87	34.0

Table 2 (cont.)

Question	Cyclist (*n* = 100)		Noncyclists (*n* = 256)	
	n	%	*n*	%
Bike-Specific Issues				
What specific issues about the bicycle influence your cycling behaviors?				
I don't know how to work the gears.	5	5.0	24	9.4
I'm afraid that I'll get stranded with a flat tire.	7	7.0	31	12.1
I'm not confident in using a bike lock.	5	5.0	39	15.2
I can never get my brakes working right.	5	5.0	19	7.4
I don't know how to carry books or other items on my bike.	9	9.0	75	29.3
I'm afraid my bike will get stolen.	8	8.0	61	23.8
I wish I knew more about general bike maintenance.	15	15.0	42	16.4
Appearance				
What appearance related factors influence your cycling decisions?				
My clothing while riding.	24	24.0	90	35.2
Difficulty bringing spare clothing.	15	15.0	42	16.4
Appearance after cycling.	35	35.0	102	39.8
Helmets mess up my hair.	19	19.0	88	34.4
I feel silly with a helmet on.	32	32.0	97	37.9
I feel or look silly on a bike.	5	5.0	63	24.6
No other people in the area cycle.	5	5.0	11	4.3
Other cyclists look fit and I don't.	6	6.0	25	9.4
My shoes are inappropriate.	9	9.0	30	11.7

Interpersonal Factors and Cycling

Chi-square analysis was performed on all of the interpersonal cycling factors. Of these, two interpersonal factors were statistically significant: "vehicles turning in front of cyclists" and "crossing intersections" ($p = .011$ and $p = .023$, respectively). When all of the interpersonal cycling factors were analyzed as a single grouped factor, interpersonal cycling factors as a whole were not statistically significant ($p = .170$).

Institutional Factors and Cycling

Chi-square analysis was performed on all of the institutional barriers and facilitators. Of the institutional factors that were barriers to cycling, five were statistically significant (Table 4). For example, "inadequate bike lanes" and "connectedness" were significant ($p \leq .001$ and $p = .001$, respectively). Of the institutional factors that facilitated cycling, 11 were significant. For example, indoor bike parking as an institutional facilitator was statistically significant ($p \leq .001$). When all of the institutional factors were analyzed as a single grouped factor, institutional factors as a whole were statistically significant ($p \leq .001$).

Table 3
Interpersonal Cycling Factor Results

Question	*p*
Traffic Interaction Concerns	
What are you specific concerns about bicycling in traffic?	
Volume of motor vehicles	$p = .156$
Speed of automobiles	$p = .088$
Moving vehicles	$p = .284$
Distracted driving	$p = .446$
Possibility of bike getting stolen while it is parked	$p = .418$
Insufficient enforcement of both cycling and traffic laws	$p = .057$
Motorists who run red lights and stop signs	$p = .179$
Vehicles turning right in front of me when I'm going straight	$p = .011$*
Crossing at intersections	$p = .023$*

*$p \leq .05$.

Table 4
Institutional Cycling Factor Results

Question	*p*
Institutional Barriers	
What community or organizational factors influence your cycling decisions?	
There are inadequate bike lanes or bike paths in my area.	$p \leq .001$***
The local roads are too busy for me to cycle on them.	$p = .937$
The University of Alabama is not well connected to the city of Tuscaloosa.	$p = .001$**
Some of my routes are not well lit.	$p = .396$
The roads are in terrible shape.	$p = .387$
It's difficult to ride my bike to transit.	$p = .147$
I dislike car fumes.	$p = .040$*
There is nowhere to park my bike.	$p = .003$**
There are no facilities for locking or securing my bike.	$p = .128$
There is no place to change my clothes after cycling to campus.	$p = .024$*

Table 4 (cont.)

Question	***p***
Institutional Facilitators	
What services/facilities would you be interested in using at UA if they were offered?	
Covered parking	$p = .428$
Indoor bike parking	$p \leq .001$***
Locker/shower facilities	$p = .257$
Bike lockers	$p = .002$**
Bike repair classes	$p = .043$*
Bike safety classes	$p = .303$
Ladies-only cycling classes	$p = .424$
Organized social cycling events	$p \leq .001$***
Beginner cycling classes	$p = .970$
More direct routes	$p \leq .001$***
More security cameras on bike racks	$p = .024$*
More bike lanes	$p \leq .001$***
Wider lanes on the road	$p = .112$
Better markings/signage	$p = .005$**
More connectivity to downtown/shopping	$p = .002$**
Better lighting along routes	$p = .592$
More bike racks near buildings	$p \leq .001$***
More bike racks near commutes parking lots	$p \leq .001$***
Ability to bring bike on Crimson Ride	$p = .002$**

*$p \leq .05$. **$p \leq .01$. ***$p \leq .001$.

Discussion

Limitations

Although the findings in this study provide useful information, there are a number of limitations. For instance, the data were collected from a nonparametric convenience sample. Though convenience sampling is one of the most common forms of data collection (Farrokhi & Mahmoudi-Hamidabad, 2012), the sample may not be ideally representative of the campus population, limiting generalizability (Freedman, 2009). The researchers attempted to ensure a broad sample by recruiting students from different colleges in the university. Another limitation pertains to the self-reported data. Self-reported data could be problematic in terms of accuracy in recall or reluctance in answering questions (Northrup, 1997).

Compared to the overall number of cyclists in the U.S. population (0.2%), the number of cyclists in the student sample of this study was much higher at 28.1% (McKenzie, 2014). This disparity in cycling rates is most likely due to differences in the populations studied (i.e., university students compared to broader populations), level of current of physical activity (the current sample and the University of Alabama ACHA-NCHA results indicate students' physical activity levels are higher than the national average), and the study settings (i.e., university campus vs. broader community settings; American College Health Association, 2011). For instance, cycling is likely higher on college campuses because of the ease of traveling between buildings and the shorter commutes compared to cycling in the broader community.

Conclusions

Despite the positive outcomes associated with cycling, few studies have explored bikeability on university campuses (Bopp et al., 2011). Lacking in particular are studies that link theoretical frameworks to data analyses (Bonham & Koth, 2010; Sisson & Tudor-Locke, 2008). In this study, the researchers addressed this gap by using the Social Ecological Model as a framework to examine the intrapersonal, interpersonal, and institutional factors influencing cycling behaviors on the campus of the University of Alabama.

Recommendations for practice. There are several implications for this study. Practical and statistical significance of the study findings expand understanding of campus cycling from the student perspective. The findings provide direction for advancing campus cycling. For instance, each of the identified predictors, including perceived safety and improved infrastructure, may be used in interventions to increase cycling. For example, interventions could include campus campaigns to promote cycling among specific racial/ethnic groups, awareness and education initiatives to address students' personal safety concerns, increased cycling signage and travel paths, bike repair and maintenance classes, accessible bike parking, and other interventions. Application of the Social Ecological Model may be useful in developing such programs to relate to the population and infrastructure of the university environment and to ensure that promotion planners consider individual, social, and environmental influences on cycling behavior for leisure and transportation.

Of the University of Alabama (UA) cyclists, most cyclists were female (73.9%), which contrasts with national statistics, which indicated the male population cycles more (Harris, 2011). However, given the majority of UA commuting was a short distance (less than 5 miles) and the speed limit was 35 mph or lower, the finding is consistent with international studies that indicate a negative relationship between gender and speed. Stigell (2011) reported that slower velocity of motor vehicles often correlates with more female cyclists, as they feel safer on the roadway. Such results lend credence to arguments that supportive structural environments improve feelings of personal safety and biking practices among female students.

There were significant differences in race and ethnicity among cyclists, and the findings are consistent with previous research (McKenzie, 2014). For instance, non-Hispanic White students (84.0%) made up the majority of cyclists on the study campus. African American students represented the lowest percentage of cyclists (5.0%). Finally, those who identified with two or more races represented 11.0% of UA cyclists. These findings have implications for targeted interventions to encourage biking in racial and ethnic minority groups.

Key conclusions can be drawn about the influence of factors at three ecological levels on cycling. Several intrapersonal factors were significant. Though personal safety factors were not significant when grouped as one variable, bike-specific issues and appearance factors were significant separately. The information obtained from the intrapersonal level of analysis can be used to address barriers identified by students (both cyclists and noncyclists). For instance, the study findings indicate that inadequate knowledge about general bike maintenance is a significant hindering factor for noncyclists. Thus, increasing equipment use and maintenance knowledge among noncycling students might increase participation (Pucher et al., 2010). Similarly, looking or feeling "silly" while wearing a helmet and concerns about clothes while riding were significant factors for respondents and represent opportunities for college campuses to address social norms by promoting the fashion, function, and popularity of athletic gear (Dill & McNeil, 2013). By hosting bike rallies and cycling education classes, the university could shift perceptions among all students, but especially among those who are currently cycling without a helmet or are yet considering cycling.

Although two interpersonal-level factors were significant, cycling factors at the interpersonal level were not statistically significant overall and are not important predictors of cycling. This finding is important and provides guidance to campus planners on an area needing less attention in cycling promotion efforts. However, given the significant findings of two specific interpersonal factors (i.e., student concerns about "vehicles turning in front of cyclists" and "crossing intersections"), campus stakeholders should consider techniques to promote a social norm of coexistence between drivers and cyclists (Stigell, 2011).

To improve interpersonal-level concerns will require consideration of institutional barriers and facilitators. In the results of this study, factors at the institutional level were important predictors of cycling. The findings support previous research that indicates that facilities and infrastructure make cycling safer, easier, more effective, and attractive to individuals and groups (Dill, 2004).

Recommendations for future research. The utility of this study could be improved with a larger sample and the addition of surveillance of cyclists. The advancement of campus cycling from a health promotion and education approach could benefit tremendously from studies that include faculty and staff and from larger comparative studies between universities. For these studies, researchers should also collect qualitative information from cyclists to address improved routes and infrastructure (Sisson & Tudor-Locke, 2008). Using information about significant predictors of cycling behaviors to target programming is the first step. Rendering such targeted programs effective at interrelated ecological levels and rigorously evaluating them is the next.

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