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## The physical environment in family child care homes and children's physical activity

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### Abstract

**Background**—Family child care homes (FCCHs) are the second largest provider of child care in the United States, yet little is known about how this setting influences children's physical activity, particularly related to the physical environment. Thus, the purpose of this study was to determine what aspects of the FCCH physical environment facilitate or hinder children's physical activity.

**Methods**—Data were collected from 166 FCCH providers and 496 preschool aged children in 2013–2014 as part of the Keys to Healthy FCCHs study. Children's moderate to vigorous physical activity (MVPA) was measured using Actigraph GT3X+ accelerometers. Wear data from the child care day were isolated and cut-points were applied in order to calculate children's minutes of MVPA per hour. FCCH-level estimates of child MVPA per hour were calculated. Indoor and outdoor physical environment characteristics were assessed during a two-day observation using the Environment and Policy Assessment and Observation (EPAO) modified for FCCHs. General linear models were used to examine the relationship between indoor, portable play equipment, and outdoor FCCH physical environment characteristics and children's MVPA per hour.

**Results**—Only indoor play space was significantly associated with children's MVPA ( $\beta=0.33$ ;  $p=0.034$ ), indicating that when provided with more indoor space for active play, children were more physically active. No significant associations were noted between portable play equipment or the outdoor environment and children's MVPA.

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**Conflicts of interest:** none

**Conclusions**—Indoor space was the only physical environment characteristic associated with children’s MVPA, suggesting that teaching FCCH providers how to best utilize their indoor play space for active play may be a way to promote children’s physical activity. Futures studies should explore the impact of other environmental characteristics of the FCCH (e.g., provider practices and policies) on children’s physical activity.

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## INTRODUCTION

Given the high prevalence of childhood overweight and obesity, increased physical activity is key to obesity prevention in young children. (Reilly, 2008) Furthermore, regular physical activity during early childhood is associated with many other benefits including improved cardiometabolic health and healthy gross motor and musculoskeletal development. (Timmons et al., 2012) Children tend to be most active during early childhood, (Reilly, 2016; Troiano et al., 2008) making this an optimal time for the promotion of healthy physical activity habits, especially since these behaviors develop early and tend to track throughout childhood and adolescence. (Jones, Hinkley, Okely, & Salmon, 2013)

In the United States, most young children spend some time in child care, a setting that has been shown to be potentially influential in promoting young children’s physical activity. (Hinkley, Crawford, Salmon, Okely, & Hesketh, 2008; Larson, Ward, Neelon, & Story, 2011; Ward, Vaughn, McWilliams, & Hales, 2010) Most children in non-relative care attend early care and education (ECE) centers and, as a result, much of the literature on physical activity promotion in child care has focused on ECE-based care. However, of the nearly 7 million children in non-relative care, around 1.5 million children are cared for in family child care homes (FCCHs), (Laughlin, 2013) which are small businesses operated out of providers’ own homes. Compared to ECE centers, much less is known about children’s physical activity and the physical activity environment in FCCHs. There is evidence, however, that children cared for in FCCHs do not obtain sufficient amounts of activity. (Delaney, Monsivais, & Johnson, 2014; Rice & Trost, 2014; Temple, Naylor, Rhodes, & Higgins, 2009)

Due to the unique nature of caring for children in the providers’ own homes, there is potential for wide variation in the characteristics of these environments. In particular, the physical structure of the home is different from ECE centers and potentially highly variable among FCCHs, making it necessary to understand what aspects of the physical environment support or hinder children’s physical activity. Like in ECEs, elements such as suitable space for both indoor and outdoor play, availability and variety of portable play equipment, and less fixed play equipment may support physical activity. (Bower et al., 2008; Brown et al., 2009; Dowda et al., 2009; Henderson, Grode, O’Connell, & Schwartz, 2015; Sugiyama, Okely, Masters, & Moore, 2012; Trost, Ward, & Senso, 2010) However, only two studies have examined how the physical environment of FCCHs impacts children’s activity. Gunter and colleagues found that a variety of fixed play equipment, active play with portable play equipment, and suitable space for indoor play were all associated with higher levels of activity, while (Gunter, Rice, Ward, & Trost, 2012) Vanderloo and colleagues found no association between environmental characteristics and children’s activity. (Vanderloo, Tucker, Johnson, Burke, & Irwin, 2015)

The relationship between the physical environment in FCCHs and children's physical activity remains unclear. The current evidence is limited to studies with small samples that have included predominantly non-Hispanic white providers and that have been limited by their measurement of the physical environment. Therefore, the first aim of our study was to describe the physical environment as it relates to physical activity in FCCHs using an observational tool modified specifically for use in FCCHs. Second, we sought to determine what aspects of the physical environment are associated with children's moderate to vigorous physical activity (MVPA). Based on previous literature, we hypothesized that children would have more minutes of MVPA per hour in FCCHs with greater availability of both indoor and outdoor play space, more variety and better accessibility of portable play equipment, more active landscape features, and in contrast to ECE centers, a greater variety of active fixed play equipment.

## METHODS

This study utilized baseline data from the Keys to Healthy FCCHs trial, a cluster-randomized trial designed to evaluate the efficacy of a childhood obesity prevention intervention targeting FCCHs. (Ostbye et al., 2015) All study protocols were approved by the University of North Carolina Chapel Hill and Duke University Institutional Review Boards.

### Recruitment

Recruitment details for this trial have been described elsewhere. (Ward, Vaughn, Burney, & Østbye, 2016) Briefly, FCCHs were recruited from 26 counties in central North Carolina. FCCHs were identified through a publicly available database of child care facilities and were invited to participate in the study. To be eligible, FCCHs had to have at least two children enrolled between the ages of 18 months and 4 years; serve at least one meal and one snack to children each working day; be open all year; and have been in business for at least two years with no plans to close in the upcoming year. Eligible FCCHs received a welcome packet that included a consent form and parent packets. Parent packets included information on the study and a consent form for the child's participation in the study. To remain eligible, providers had to return their consent form as well as the consent forms of at least two parents with children in the target age range. Once the consent forms were returned, providers were scheduled to complete baseline data collection.

### Data Collection

Data collection occurred over two non-consecutive days at the FCCH (e.g., Tuesday/Thursday). Data collectors trained and certified in the study protocols arrived at the FCCH in the morning before the first meal and stayed at the FCCH until the majority of children had left. During this time, data collectors fit participating children and the provider with accelerometers, measured child and provider anthropometrics, distributed surveys to providers, and completed a full day observation of the physical activity and diet environment.

## Measures

**Physical Environment**—The physical environment of the FCCH was assessed using the Environment and Policy Assessment and Observation (EPAO) instrument by a trained research assistant. The EPAO is a comprehensive tool used to examine the nutrition and physical activity environment of ECE centers. It includes a day-long observation of all practices and provisions in the center as well as a document review of the center's written policies. (Ward et al., 2008) Since the original EPAO was developed as an evaluation tool for ECE centers, it was modified to capture aspects unique to FCCHs. (Vaughn et al., 2017) Sub-scores from the modified EPAO containing items used in these analyses demonstrated acceptable inter-rater reliability ( $ICC > 0.80$ ). Data collectors completed the EPAO on each day of data collection. However, some items relating to the physical environment (e.g., space, fixed play equipment) were only captured on the first day as these items were unlikely to change over the data collection period.

**Physical Activity**—Children's physical activity was assessed using ActiGraph GT3X+ accelerometers (ActiGraph, Pensacola, Florida). Monitors were programmed to collect data in 15-second epochs and were worn on an adjustable belt on the child's right hip for three consecutive days, except while the child was sleeping at night or participating in water activities. Once monitors were returned, the data were downloaded and processed to determine non-wear time using the National Health and Nutrition Examination Survey non-wear processing algorithm, which classifies non-wear time as a period of 60 minutes with zero counts recorded. (Troiano, 2007). Because the Keys intervention was focused on physical activity in the FCCH, for valid physical activity data, children must have had at least 2.5 hours of waking wear time for at least 2 days while at the FCCH. The cutoff of 2.5 hours was chosen to allow data from a few FCCHs who operated half day programs was included. Established cut points for preschool children were applied to the 15-second epoch data files to determine activity intensity. (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008; Pate, Almeida, McIver, Pfeiffer, & Dowda, 2006) Physical activity during the child care day was isolated using FCCH open times and time stamps from the EPAO to assign a start and end time at the FCCH on each day the child wore an accelerometer.

**Additional measures**—Using standard procedures, trained data collectors measured providers' height to the nearest 1/8 inch using a Shorr stadiometer (Shorr Productions, Olney, MD) and weight to the nearest 0.1 lb. using a Seca model 874 portable electronic scale (Seca Corporation, Columbia, MD). Measurements were collected in duplicate and averaged for a final value. A demographic questionnaire was completed by parents to identify children's age, sex, and race/ethnicity. Providers completed a self-report demographic questionnaire to determine the number of children cared for in the FCCH along with provider age, gender, race/ethnicity, income and education/training.

## Analyses

Using individual items from the EPAO, 11 summary variables were created to summarize the physical activity physical environment (Table 1). These variables were broadly grouped into three categories: the indoor environment, portable play equipment, and the outdoor environment. Within the outdoor environment, fixed play equipment and landscape feature

items were categorized based on their potential to benefit physical activity (i.e., active) or other areas of development (i.e., creativity or attractiveness). Because the exposure variables were at the FCCH level, a FCCH level estimate of child MVPA per hour was created by averaging the physical activity of all participating children at each FCCH and dividing by the average wear time while at the FCCH.

Descriptive statistics including means, standard deviations, and frequencies were calculated to summarize characteristics of the sample and the physical activity physical environment. General linear models were used to examine the association between physical environment variables and children's MVPA per hour. One FCCH did not have any children with valid physical activity data and was thus excluded from the analysis. Separate models were constructed for each of the three categories of the physical environment. Associations were considered statistically significant at the  $\alpha=0.05$  level; however, given the paucity of research on FCCHs, we also noted associations of  $\alpha=0.10$  or less. Outdoor time provided, provider physical activity training, and provider income were included as covariates in the adjusted models. Covariates were identified by examining bivariate associations between children's MVPA per hour and variables known to influence child physical activity. (LaRowe et al., 2016; Razak et al., 2018) Variables with a correlation  $p$  value  $< 0.4$  were further examined for inclusion in the adjusted model. AIC and BIC fit statistics were used to determine the best fitting combination of covariates. All analyses were conducted using SAS version 9.4 (SAS Institute, Inc., Cary, NC).

## RESULTS

All providers were female with a mean age of 49.3 ( $\pm 9.1$ ) years (Table 2). Most providers were African American (74%), had an income between \$25,000 and \$50,000 (54%), had an Associate degree (50%), and were obese or overweight (90%). On average providers cared for around seven children in their FCCH. Half of the children were female (50%), the mean age was 35.7 ( $\pm 11.4$ ) months, and most children were African American (63%).

Most FCCHs had limited indoor space available for different types of movement activities (Table 3). Only 18 FCCHs (11%) had enough indoor space for all types of gross motor activities. Most homes had a television (76%), while few homes had books (47%) and posters (34%) promoting physical activity. The variety of portable play equipment was limited to mostly push-pull toys (e.g., wagons, scooters; 89%) and throwing toys (e.g., balls; 92%). Although portable play equipment was generally available for children to use ( $1.23 \pm 0.59$ ), accessibility of the equipment was typically low ( $0.48 \pm 0.31$ ). Most homes had adequate outdoor space (88%). On average, FCCHs had about five different types of fixed play equipment ( $4.95 \pm 2.6$ ). Of the fixed play equipment, there were generally about three types of fixed play equipment that were considered activity promoting ( $2.74 \pm 1.8$ ) compared to two types that were considered non-active, but could facilitate creativity and learning ( $2.20 \pm 1.4$ ). The most common types of active fixed play equipment were basketball hoops (65%), balancing surfaces (56%), and tricycle tracks (51%), while picnic tables (64%) and play houses (60%) were the most common creative fixed play equipment. FCCHs tended to have a similar amount of active ( $1.61 \pm 0.87$ ) and attractive ( $1.74 \pm 1.3$ ) landscape features with most FCCHs having a grassy area (91%) and large trees (68%).

Mean wear time while in FCCHs was 6.5 ( $\pm 1.4$ ) hours. FCCH level physical activity estimates show that children spent an average of 38.5 ( $\pm 4.3$ ) minutes per hour engaged in sedentary behavior, 16.8 ( $\pm 3.2$ ) minutes per hour engaged in light activity, and 4.7 ( $\pm 1.6$ ) minutes per hour engaged in MVPA. For the indoor environment, space available was significantly associated with children's MVPA in the unadjusted model ( $\beta=0.38$ ,  $p=0.015$ , Table 4). After controlling for covariates, the association remained significant in the adjusted model ( $\beta=0.33$ ,  $p=0.034$ ). Additionally, in the unadjusted model, there was a positive relationship between the number of media devices and children's MVPA, but this association was not significant ( $\beta=0.20$ ,  $p=0.09$ ). None of the portable play equipment or outdoor environment variables was significantly associated with children's MVPA. There was a positive relationship between active landscape features and children's MVPA in the adjusted model ( $\beta=0.27$ ,  $p=0.08$ ), but this relationship was not statistically significant.

## DISCUSSION

FCCHs are an important source of care for young children. In our study of 166 FCCHs in North Carolina, we found limited variation in the physical environment related to physical activity. The amount of indoor space available for active play was the only environmental characteristic positively associated with children's MVPA. Environmental characteristics related to the outdoor environment and portable play equipment were not significantly associated with children's MVPA.

The amount of indoor space for physical activity has been highlighted as an area for improvement in FCCHs. (Trost, Messner, Fitzgerald, & Roths, 2009) Most homes in our study had limited amounts of indoor space and very few had enough indoor space to promote a wide range of gross motor activities. In line with our hypothesis, our findings show that as the amount of space increased, so did children's physical activity. These are consistent with findings from another study that also observed higher levels of physical activity in FCCHs with more space. (Gunter et al., 2012) This suggests that helping FCCH providers to better structure the indoor environment in order to ensure adequate indoor space for active play, may be a way to increase children's physical activity in this setting. Policy efforts may recommend specific practices (e.g., providing open space for gross motor movements or play space with movable furniture) to allow adequate space for active play indoors.

Related to the indoor environment, we found a positive but non-significant relationship between the number of media devices available and children's MVPA. Since there typically is an inverse relationship between screen time and physical activity, this relationship was unexpected. However, other analyses from this trial found that providers' screen time-related practices were associated with children's MVPA, such that when providers had better screen time practices (e.g., limiting screen time), children's MVPA decreased. (Mazzucca, Under review) Similarly, less screen time was associated with more sedentary behavior. Anecdotal evidence from the observations suggests that providers often use media to promote physical activity (e.g., children dance along to a YouTube video). Media and screen time may actually facilitate activity rather than promote sedentary time in this setting. Future studies

should further explore the impact of active screen time and the potential for this to improve children's physical activity.

Contrary to our hypotheses, we did not find any significant associations between either the outdoor environment or portable play equipment and children's MVPA. There was a positive relationship between active landscape features and children's MVPA that approached significance in the adjusted models. Although this result should be interpreted cautiously, it suggests that active landscape features could potentially have a positive influence on children's physical activity. Future studies are need to assess this relationship, but teaching FCCH providers to encourage active play using landscape features available to them may be a way to promote physical activity.

Our limited findings regarding portable play equipment and outdoor environment may be explained by a number of factors. There was low variation in the physical environment and children's physical activity, which may have precluded our ability to detect significant effects. The low variation may be explained by the fact that our sample was fairly homogenous demographically and geographically. Additionally, the physical environment is only one aspect of the physical activity environment. Other supportive elements of the environment such as other provisions (e.g., time allotted for active play), provider physical activity practices or FCCH physical activity policies may have a greater positive or negative impact on children's physical activity level. Finally, FCCH providers typically care for children between the ages 0–5 years and in some cases, older children after school. Compared to ECE-center providers who care for groups of children within a narrower developmental range (e.g., 3–4 year olds), it may be easier for FCCH providers to provide more indoor physical activity opportunities rather than to manage the multiple age groups outdoors.

A strength of this study is that we were able to objectively measure children's physical activity as well as the physical environment using a validated instrument designed specifically for use in FCCHs. While indoor space was positively associated with MVPA, we were unable to capture absolute or per/child square footage of the indoor space, which precludes specific size recommendations. Future iterations of the EPAO may consider quantifying indoor space. Our sample of providers and children were from central North Carolina and were predominantly African American and lower income. Although this is a minority population that is often underrepresented in research, our results may not be generalizable to other geographical areas or populations. Future studies should seek to better understand other environmental factors (e.g., physical policies, provider practices) that may also influence children's physical activity.

## CONCLUSION

Low-levels of physical activity of children while in FCCHs indicates that there is an opportunity for physical activity promotion within this setting. The indoor environment might be of particular importance for interventions targeting FCCHs for physical activity promotion.

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**KEY MESSAGES**

- Children in FCCHs spend large amounts of time in sedentary behavior and engage in relatively little MVPA, making this an ideal setting for physical activity promotion.
- Examining the physical environment, the indoor environment, particularly the amount of space available for active play, appears to be influential in promoting children's physical activity in this setting.
- Additional research is needed to understand other environmental factors that may impact children's physical activity while in FCCHs.

**Table 1**

Description of physical activity physical environment variables

Exposure Variable	Score (range)	Items (response options)
<b>Indoor Physical Activity Environment</b>		
Media devices available	Sum of total number of media items (0–4)	TV, DVD/VCR, computer, video game system (yes/no) <sup>a</sup>
Indoor play space	Single item (1–5)	Rate the home in terms of the space available for active play games/gross motor activities (1 = no room to 5 = room for all activities)
Physical activity promotion materials	Sum of total number of physical activity promotion materials (0–3)	Physical activity books, physical activity posters, screen time posters <sup>b</sup> (yes/no)
<b>Portable Play Equipment (PPE)</b>		
PPE variety	Sum of different types of portable play equipment (0–6)	Sand water toys, jumping toys, push-pull toys, twirling toys, throwing toys, crawling toys (yes/no) <sup>a</sup>
PPE availability	Sum of the number of times PPE was available for outdoor play <sup>c</sup> (0–2)	Children had to take turns playing with outdoor toys because not enough were available (yes/no) <sup>a</sup>
PPE accessibility	Sum of the number of times PPE was offered divided by the number of play periods observed <sup>c</sup> (0–2)	While outside, children could easily get out PPE and toys (balls, tricycles, large trucks, wheel barrow, etc.) without help from the provider (yes/no) <sup>a</sup>
<b>Outdoor Physical Activity Environment</b>		
Outdoor space	Single item (1–4)	Which statement best describes the area outside the home where children are allowed to play? (1 = no space for running games to 4 = space for large group running games) <sup>b</sup>
Active fixed play equipment	Sum of total number of activity promoting fixed play equipment structures (0–11)	Balancing surface, basketball hoop, climbing structure, merry-go-round, swimming pool, water play area, see-saw, slide, swinging equipment, tricycle track, tunnels (yes/no)
Active landscape features	Sum of total number of activity promoting landscape features (0–5)	Trees children can climb, variation in ground, grassy area, rocks large enough to climb, a hill for rolling down or climbing up (yes/no)
Creative fixed play equipment	Sum of total number of fixed play equipment structures that contribute to the quality of the outside environment (0–5)	Sandbox, benches, picnic table, small stage or raised deck, play house (yes/no)
Attractive landscape features	Sum of total number of landscape features that contribute to attractiveness of outside environment (0–4)	Large trees, small trees, shrubs, flowering plants

<sup>a</sup> data was collected during both days of observation and was averaged in order to create the summary score

<sup>b</sup> item reverse coded;

<sup>c</sup> item answered once in the morning and once in the afternoon

**Table 2**

## Characteristics of FCCH providers and children

<b>Provider characteristics (n=166)</b>	
Female, n (%)	166 (100)
Age in years, mean (SD)	49.3 (9.11)
Race, n (%)	
Black or African American	123 (74.1)
White	30 (18.1)
Other	13 (7.82)
Hispanic or Latino	8 (4.8)
Income, n (%) <sup>a</sup>	
< \$25K	38 (23.6)
\$25K – 50K	87 (54.0)
\$50K +	36 (22.4)
Education, n (%) <sup>b</sup>	
High school/GED	40 (24.5)
Associate degree	81 (49.7)
Bachelor's degree	37 (22.7)
Master's degree or higher	5 (3.07)
BMI, mean (SD)	33.2 (7.53)
BMI ≥ 25, n (%)	149 (89.8)
# of children in FCCH, mean (SD) <sup>c</sup>	7.22 (3.57)
Ever had PA training <sup>d</sup>	63 (39.6)
<b>Child characteristics (n=496)</b>	
Female, n (%)	250 (50.4)
Age in months, mean (SD)	35.7 (11.4)
Race, n (%)	
Black or African American	314 (63.3)
White	135 (27.2)
Mixed race	42 (8.47)
Other	5 (1.01)
Hispanic or Latino, n (%) <sup>e</sup>	40 (4.05)

<sup>a</sup>  
n=161;<sup>b</sup>  
n=163;<sup>c</sup>  
n=165;<sup>d</sup>  
n=159;<sup>e</sup>  
n=494

**Table 3**

Characteristics of the physical activity physical environment in FCCHs (n=166)

Environmental Characteristic	Mean Score (SD)	Item Frequency (% available)
<b>Physical activity indoor environment</b>		
Space availability	3.37 (0.78)	Room for limited movement activities (57)
Media availability	1.33 (0.92)	TV (76) DVD/VCR (34) Computer (22) Video games (9)
Physical activity promotion materials	1.73 (0.77)	Books encouraging activity (47) Posters encouraging activity (34) Posters encouraging screen time (8)
<b>Portable play equipment (PPE)</b>		
PPE variety	3.23 (1.36)	Sand water toys (51) Jumping toys (47) Push-pull toys (89) Twirling toys (18) Throwing toys (92) Crawling toys (55)
PPE accessibility <sup>a</sup>	0.48 (0.31)	-
PPE availability <sup>b</sup>	1.23 (0.59)	-
<b>Physical activity outdoor environment</b>		
Space availability	3.86 (0.42)	Space for large group running games (88)
Active fixed play equipment	2.74 (1.78)	Balancing surface (56) Basketball hoop (65) Climbing structures (32) Merry-go-round (5) Swimming pool (2) Water play area (7) See-saw (21) Slide (31) Swinging equipment (32) Tricycle track (51) Tunnels (12)
Creative fixed play equipment	2.20 (1.38)	Sandbox (37) Benches (42) Picnic tables (64) Small stage or raised deck (44) Play house (60)

Environmental Characteristic	Mean Score (SD)	Item Frequency (% available)
Active landscape features	1.61 (0.87)	Trees that children can climb (6)
		Variation in ground (45)
		Grassy area (91)
		Rocks large enough to climb (2)
		Hill for rolling down or climbing up (17)
Attractive landscape features	1.74 (1.27)	Large trees (68)
		Small trees (32)
		Shrubs (48)
		Flowering plants (27)

<sup>a</sup>  
n=158;

<sup>b</sup>  
n=157

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**Table 4**

Association between physical environment and children's MVPA per hour

	$\beta$ (SE)	
	Unadjusted model (n=165)	Adjusted model (n=153) <sup>a</sup>
<b>Indoor Environment</b>		
Books and posters	0.03 (0.16)	0.14 (0.16)
Media	0.20 (0.13) †	0.15 (0.14)
Indoor space	0.38 (0.15) *	0.33 (0.16) *
<b>Portable Play Equipment<sup>b</sup></b>		
Accessibility	-0.52 (0.40)	-0.52 (0.41)
Availability	0.03 (0.21)	-0.21 (0.24)
Variety	0.04 (0.10)	0.08 (0.10)
<b>Outdoor Environment</b>		
Outdoor space	-0.17 (0.31)	-0.19 (0.31)
Active fixed play equipment	0.07 (0.08)	0.07 (0.08)
Creative fixed play equipment	0.01 (0.10)	0.05 (0.11)
Landscape attractiveness	-0.01 (0.10)	-0.05 (0.11)
Active landscape	0.24 (0.15)	0.27 (0.16) †

\*  
p < 0.05†  
p < 0.10<sup>a</sup>adjusted for outside time, provider physical activity training and income<sup>b</sup>unadjusted model n=156; adjusted model n=144