

UC San Diego

UC San Diego Previously Published Works

Title

U.S. Adolescent and Adult Women's Experiences Accessing and Using Toilets in Schools, Workplaces, and Public Spaces: A Multi-Site Focus Group Study to Inform Future Research in Bladder Health

Permalink

<https://escholarship.org/uc/item/5w21g3pb>

Journal

International Journal of Environmental Research and Public Health, 16(18)

ISSN

1661-7827

Authors

Camenga, Deepa R
Brady, Sonya S
Hardacker, Cecilia T
[et al.](#)

Publication Date

2019-09-01

DOI



10.3390/ijerph16183338

Peer reviewed



Article

U.S. Adolescent and Adult Women's Experiences Accessing and Using Toilets in Schools, Workplaces, and Public Spaces: A Multi-Site Focus Group Study to Inform Future Research in Bladder Health

Deepa R. Camenga ^{1,*} , Sonya S. Brady ², Cecilia T. Hardacker ³, Beverly R. Williams ⁴, Jeni Hebert-Beirne ⁵, Aimee S. James ⁶, Kathryn Burgio ⁷, Jesse Nodora ⁸, Jean F. Wyman ⁹, Amanda Berry ¹⁰ , Lisa K. Low ¹¹ and The Prevention of Lower Urinary Tract Symptoms (PLUS) Research Consortium ¹²

¹ Department of Emergency Medicine, Yale School of Medicine, New Haven, CT 06519, USA

² Division of Epidemiology & Community Health, University of Minnesota School of Public Health, Minneapolis, MN 55454, USA

³ Department of Education, Center for Education, Research and Advocacy, Howard Brown Health, Chicago, IL 60613, USA

⁴ Department of Medicine, Division of Gerontology, Geriatrics and Palliative Care, University of Alabama at Birmingham, Birmingham, AL 35233, USA

⁵ Division of Community Health Sciences, School of Public Health, University of Illinois at Chicago, Chicago, IL 60612, USA

⁶ Division of Public Health Sciences, Department of Surgery, Washington University in St Louis School of Medicine, St Louis, MO 63110, USA

⁷ Department of Medicine, University of Alabama at Birmingham and Department of Veterans Affairs, Birmingham, AL 35233, USA

⁸ Department of Family Medicine and Public Health, University of California San Diego School of Medicine & Moores Cancer Center, La Jolla, CA 92093, USA

⁹ School of Nursing, University of Minnesota, Minneapolis, MN 55455, USA

¹⁰ Children's Hospital of Philadelphia, Philadelphia, PA 19104, USA

¹¹ Department of Health Behavior and Biological Sciences, School of Nursing, University of Michigan, Ann Arbor, MI 48109, USA

¹² Minneapolis, MN 55414, USA

* Correspondence: deepa.camenga@yale.edu

Received: 17 June 2019; Accepted: 6 September 2019; Published: 10 September 2019



Abstract: The World Health Organization recognizes access to clean and safe toilets as crucial for public health. This study explored U.S. adolescent and adult cisgender women's lived experiences accessing toilets in schools, workplaces, and public spaces. As part of the Prevention of Lower Urinary Tract Symptoms (PLUS) Research Consortium, we conducted 44 focus groups with female participants (n = 360; ages 11–93). Focus groups were stratified by age (11–14, 15–17, 18–25, 26–44, 45–64, 65+) and conducted across 7 geographically diverse U.S. sites from July 2017–April 2018. Using a transdisciplinary approach, we conducted conventional qualitative coding informed by our PLUS conceptual framework and used content analysis processes to identify salient themes. Across settings, toilet access was restricted by “gatekeepers” (i.e., individuals who control access to toilets). In contrast, self-restricting toilet use (deciding not to use the toilet despite biologic need to urinate) was based on internalized norms to prioritize school and job responsibilities over urination. In public spaces, self-restricting use was largely in response to lack of cleanliness. Across the life course, participants perceived gender disparities in the ability to easily access public toilets. Further research is needed to determine if and how these factors impact bladder health across the life course.

Keywords: bladder health; female; toilet; qualitative research; focus groups

1. Introduction

The World Health Organization recognizes access to and use of clean and safe toilets as crucial for public health [1]. To date, public health efforts to improve toilet access and use have largely focused on the prevention of a variety of infectious diseases related to contaminated drinking water, with less public health attention on the need for toilet access to maintain bladder health and prevent lower urinary tract symptoms (LUTS) [1]. Toilet access, or the ability to approach or enter bathrooms for toileting, has been identified as a potential protective factor for bladder health [2,3]. Broadly defined, bladder health is “a complete state of physical, mental, and social well-being related to bladder function and not merely the absence of lower urinary tract symptoms (LUTS)” [4]. Given this definition of bladder health, it is essential to have an understanding of social processes and environmental contextual factors that may influence toilet access as a potential protective factor for bladder health.

Existing research on factors that reduce toilet access and use has largely focused on the environmental context of low- and middle-income countries or narrow age groups [3,5]. Research conducted in higher-income countries has shown that children’s concerns related to cleanliness, odor, privacy and safety may deter bathroom use [6–9]. Similar concerns about cleanliness have been shown to influence women’s use of public toilets in the United States (U.S.) [10]. In the workplace, “waiting too long to urinate” has been associated with LUTS in women [11,12], and women in professions with limited or restricted toilet access have a higher prevalence of LUTS compared to occupations with less restricted access [11,13]. Although these studies provide important insights about the availability of toilets and the factors impacting toilet access within U.S. populations, they neither apply a life course perspective nor examine experiences across diverse settings.

The purpose of this qualitative study was to explore U.S. adolescent and adult cisgender women’s lived experiences navigating toilet access and use across a variety of settings outside of the home, namely schools, workplaces, and public spaces. Unlike quantitative research which typically is powered to identify statistical significance by examining the views of a broad number of individuals from representative populations, this qualitative study is designed to explore in-depth accounts of smaller numbers of women to identify potential hypotheses about the factors influencing perceptions, beliefs, and behaviors around women’s toilet access in the U.S. This study also examines experiences of adolescent and adult women at different stages of the life course, from adolescence to older adulthood, which facilitates development of hypotheses about similar and distinct influences across different age groups and life stages. Ultimately, the findings can inform and enhance our knowledge of how to promote healthy bladder habits and function in adolescent and adult women and inform future bladder health research.

2. Materials and Methods

2.1. Overview

The Study of Habits, Attitudes, Realities, and Experiences (SHARE) is a qualitative study of the Prevention of Lower Urinary Tract Symptoms (PLUS) Research Consortium, a transdisciplinary network of seven geographically diverse research centers and a Scientific and Data Coordinating Center. PLUS was established to expand research related to the prevention of lower urinary tract symptoms (LUTS) and the promotion of bladder health in adolescents and adult women [14]. The SHARE study used focus group methodology to explore adolescent and adult women’s experiences, perceptions, beliefs, knowledge, and behaviors related to bladder health and function across the life course. This qualitative methodology was identified as best for meeting the study aim to gain insight through discourse and discussion within a small group of people who share a social context [15–18]. The full protocol has been

published elsewhere [19]. This paper reports an analysis of adolescent and adult cisgender women's lived experiences accessing and using toilets in schools, workplaces, and public spaces.

2.2. Participants

Participants were adolescents and adult women across a broad age range recruited at each of the seven research centers, using a variety of recruitment methods including flyers, on-line postings, word of mouth, email announcements, and referral by community partners. Applying a life course perspective, a purposeful sample of participants was recruited into focus groups stratified by age group (early adolescents: 11–14 years; adolescents: 15–17 years; young adult women: 18–25 years; adult women: 26–44 years; middle-aged women: 45–64 years; and older women: 65+ years) [20].

Participants were eligible if they were age 11 years or older, assigned female sex at birth and cisgender, spoke English or Spanish, were able to read and provide written informed consent (or assent and parental permission for those 11–14 years of age), and self-reported the absence of any physical or mental condition that would impede participation. Current known pregnancy was an exclusion criterion due to the known effects of pregnancy on LUTS. To ensure a wide range of bladder experiences, participants were included without regard to LUTS status, which was only assessed following focus group participation.

Our goal was to recruit a sample that was diverse with respect to race, ethnicity, education, socioeconomic status, physical/health conditions, LUTS status, geography (urban/rural), and language, including focus groups conducted in Spanish. Recruitment was aligned with community engagement activities of PLUS and coordinated across centers to strategically determine the composition of each focus group and ensure overall study diversity.

The study was approved by the University of Pennsylvania Institutional Review Board (IRB), which served as the central review board for six of the seven centers, and a local university IRB at the remaining site. All participants signed informed consent forms and received \$50 gift cards for their participation in the focus group.

2.3. Procedures

Between July 2017 and April 2018, focus groups were conducted within specified age groups to encourage comfortable and open communication among participants. The sessions lasted about 90 min and were conducted in community settings, such as libraries, universities, community organization meeting spaces, and churches. Focus groups were conducted by female moderators who received standardized training in the qualitative research principles adopted by the PLUS Consortium, best practices for focus group research, and the SHARE study protocol (see Hebert-Beirne, et al., for full description of moderator characteristics) [21]. Participants did not have prior relationships with the research staff, however at three research centers, participants were recruited from community partners of the research center.

Each session followed a semi-structured focus group guide informed by the PLUS conceptual framework, which was based on the social ecological model and incorporated a life course perspective [2]. The guide was arranged in five sections, consisting of 18 core items (with probes) covering the following domains: healthy bladder beliefs/attitudes, bladder knowledge acquisition, LUTS experience and care seeking, terminology, and public health messaging. The guide was piloted through mock focus groups coordinated with community partners.

Focus groups were audio-recorded and professionally transcribed verbatim. In addition, trained female investigators observed the sessions and noted analytic insights using a field note guide for documenting nonverbal communication and characterizing the focus group dynamics. After each focus group session, participants completed self-administered measures to characterize the sample in terms of demographics and LUTS status, as measured by the LUTS Tool in adults [22] or ICIQ CLUTS Survey in adolescents [23].

2.4. Data Analysis and Interpretation

Data analysis and reporting were conducted in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) guidelines (See Supplementary Table S1) [24]. Focus group transcripts and field notes were entered into Dedoose, a software program for facilitating the organization and coding of non-numerical data. We employed a protocol-driven, systematic multilevel approach to codebook development and data analysis. The first level of analysis consisted of a deductive directed content analysis (DCA) [25,26]. DCA is used when current theory or previous evidence (in this case the PLUS conceptual framework [2]) needs further description [26]. Consistent with DCA, we organized the large body of data into a coding schema aligned with social ecological components of the PLUS conceptual framework, which informed our interview guide. We then used a deductive approach to explore textual data for insights relevant to the research question, with the goal of validating and extending knowledge in the area of interest. The second level of data analysis expanded the coding structure to include the valence of the level one codes and include subcategories to document extensions or variations on the initial coding categories. The third level of data analysis utilized a phenomenological inductive lens to articulate emerging insights about social processes and cultural assumptions shaping the content of the focus group narratives.

A 4-member transdisciplinary team of researchers and two trained data coders carried out the first and second levels of data analysis. At the outset of the interpretative process, team members engaged in a reflexive process, describing their disciplinary perspectives and potential biases. This process supported the use of a transdisciplinary lens which engaged all analytic team members in the process of the analysis. All study investigators conducted the third level of data interpretation via an inductive process guided by team science and informed by a transdisciplinary perspective that utilized the integrative expertise and experience of both male and female social and behavioral scientists, medical clinicians and interventionists, public health researchers and educators, and community advocates. The key mechanisms of data interpretation included data immersion (with coded data and transcripts), investigator reflexivity and team dialogue, which led to the development of themes [27].

To ensure trustworthiness of the analysis, study investigators directly supervised coders and trained them to identify inconsistencies with codes and emerging themes. Study investigators also directly observed the focus groups and maintained a detailed log of coding and analytic decisions [28]. A validation process was performed wherein results were presented to the focus group moderators from all sites, community members at one site, and PLUS research investigators who were not directly involved in the study to gain further insights and validate themes.

The present analysis focuses on interpretive analysis of the inductively-derived codes of “Accessing Toilets”, “School”, “Workplace”, and “Community Spaces”. The unit of analysis was the group (rather than the individual), and we present data that reached saturation about accessing and using toilets in schools, workplaces, and public.

3. Results

A total of 44 focus groups were conducted with 360 participants. The number of focus groups conducted varied by age category, with more focus groups being conducted within the older age categories per the study protocol (see Table 1). The participants ranged in age from 11–93 years and represented a diverse sample across racial, socio-economic, and geographic distributions (see Supplementary Table S2). Overall, 76.4% of the participants reported LUTS in the past week, with younger participants having the lowest prevalence (44.4% in 11–14-year olds) and oldest participants having the highest prevalence (87.6% in 65+) of one or more symptoms.

Table 1. Numbers of Participants and Focus Groups, Total and by Age Category.

Number (n)	Total	Age Category					
		11–14	15–17	18–25	26–44	45–64	65+
Number of participants, total and by age category	360	18	26	51	72	104	89
Number of focus groups, total and by age category	44	4	4	6	9	11	10

Through the process of interpretive analysis, several themes related to toilet access and use emerged. Gatekeepers (defined as individuals who control access to toilets) and self-restricting toilet use (deciding not to use the toilet despite biologic need to urinate, often in response to the internalization of external norms) played a prominent role in toilet access and use across age groups. An emergent theme that also arose was gender disparities in toilet access in public spaces.

3.1. Gatekeepers

3.1.1. Schools

Gatekeepers were described by both adolescent and adult women across the life course as being particularly prominent in limiting toilet access in school settings. Adolescents identified teachers as the primary gatekeepers in the school setting; however, security guards and hall monitors also performed this role:

“Our engineering teacher, he only, he lets you go for only five minutes, and if you take one minute more, then he’s not gonna let you go to the bathroom for another week.”

—11–14 age group

“I don’t want like to go to the bathroom with a security guard having to unlock the door, especially if I go frequently, they start to ask questions too, when it’s not their business.”

—15–17 age group

Participants from other age groups provided retrospective accounts of how gatekeepers had limited their access to toilets in elementary or secondary school settings:

“If you raise your hand and, and say, “Can I go to the washroom?” Sometimes the teacher would say ‘noooo’, . . . maybe that kid had a problem and he really needed to go, so he had to sit there until it was time to go.”

—65+ age group

“I had a similar experience when I was a kid, so 35, however, many years ago. . . it was extremely embarrassing because I went because the, the teacher wouldn’t let me get up and go and so there I was in third grade with a puddle under my chair and then that creates its own stigma for the rest of my time at that school.”

—26–44 age group

Participants offered multiple explanations for gatekeeping in schools, rationalizing the process as a means of supporting optimal student learning. For example, adolescents described how gatekeepers wanted to limit time out of the classroom to encourage a “focus on [school] work”.

“I know in my Spanish class, we is not allowed to go to the bathroom at all because she always say that we have to focus on work [rather] than leaving out the class.”

—11–14 age group

“They told me I can’t [use the bathroom] because I’ll miss something, so I just stay.”

—15–17 age group

They also shared perceptions that gatekeepers assumed students would engage in misbehavior during a bathroom break:

“They think maybe you’re like playing outside, so sometimes they don’t let you go to the bathroom.”

—11–14 age group

Although gatekeepers limiting toilet access to control the potential for misbehavior could be viewed as unfair, some adolescents acknowledged that students may indeed engage in behaviors other than toileting in the restroom:

“Well, first of all, since like most of the girls go to the bathroom just to chat, they made that rule that only we can go once a day.”

—11–14 age group

“Yeah. A lot of people don’t use the bathroom. They just stay on their phones.”

—15–17 age group

“School-wise, a lot of people skip classes in the bathroom and a lot of people are in the bathroom to not go to the bathroom. So think that when schools do that [limit toilet access], they’re trying to prevent that.”

—15–17 age group

These sentiments were shared by adult women who recalled teachers with similar assumptions about misbehavior in the bathroom.

“The teacher made me sit there and wait, like, I guess they thought maybe you were playing around, you just wanted to get out of class, but no, some of us really had to get up and go to the bathroom. You tell us to sit there and hold it.”

—45–64 age group

3.1.2. Workplaces

While the role of gatekeepers was a salient theme across the life course in reference to toilet access in schools, adult women varied with respect to whether they perceived that gatekeepers limited access to toilets in occupational settings. Some participants described how managers or supervisors served as gatekeepers for employee toilet access:

“Sometimes managers micromanage it. They figure you’re getting up every 15–20 min to go to the bathroom, and they will tell you that you only have two 15-minute breaks a day.”

—45–64 age group

“You have to badge in and badge out of the bathroom because they’re watching how many breaks you take.”

—45–64 age group

Compared to the discussions that arose around the school setting, overall there was less discussion about why gatekeepers in workplaces limit access to toilets. Instead, some women described how toilet access was limited to scheduled breaks or lunch.

“Where I work, you can only pee on your breaks.”

—18–25 age group

“You had certain breaks that you could go and that’s when you could go.”

—45–64 age group

“You have to hold it until there’s a scheduled break, so you don’t have the opportunity to go when you need to.”

—65+ age group

Although some participants experienced instances wherein managers controlled access to toilets, some participants indicated they had agency in accessing and using toilets in their workplaces:

“I have no limitations on time or pressure of using the restroom in my job.”

—18–25 age group

“My work does not schedule your restroom breaks, you can go as needed, which is good.”

—25–45 age group

3.1.3. Public Spaces

Women of all ages, including adolescents, described public toilets located in commercial and non-commercial spaces. The presence of gatekeepers was not described in non-commercial toileting spaces, which included “porta-potties” and public restrooms in parks or rest stops. However, participants described a range of experiences in which store employees served as gatekeepers in commercial spaces, including small and large retail establishments (e.g., corner stores, “big-box” stores, and grocery stores). Participants explained how access to the toilets in retail establishments was dependent upon one’s ability to purchase goods, and in these cases, the store employees served as the gatekeeper:

“... what is sad is that it’s women who are at the store or business, and you tell them, ‘can I please use your bathroom? It’s an emergency?’ ‘No, you have to be a client; will you be buying something?’ ‘No, I need to use the bathroom.’ ‘No, you can’t.’ ‘It’s an emergency.’ ‘No.’”

—45–64 age group

Businesses’ concerns about liability was also described as the basis for gatekeepers’ restricting access to toilets in commercial spaces:

“... two weeks ago, I was in a discount grocery ... they said, ‘Oh, no. You can’t use the bathroom. We just cleaned it.’ And she [i.e., the woman who wished to use the toilet] was like desperate. This woman was like, ‘Please, please. I’ve got to go. I don’t know where to.’ And they said, ‘No, if you would slip and fall on the wet floor, you could sue us,’ and they would not let her use the bathroom. She was begging to use the bathroom.”

—65+ age group

In some cases, the employee would allow access to the toilet:

“It’s like the home store where you go in and there’s just a bunch of random stuff. So, I was like listen, I really need to use the bathroom. Do you guys have a bathroom? And I’m pretty sure it’s not a public bathroom but he saw that I really needed to pee, so he’s like yeah, you can use the bathroom in the back and then there’s just a bunch of like boxes.”

—15–17 age group

Participants also noted positive responses to certain retail establishments whose employees allowed access to toilets, and they generally had favorable attitudes towards these locations:

[In reference to large retail stores] *“It’s like if you have to pee, either like go inside ... and they’ll let you use the bathroom because they don’t care.”*

—25–64 age group

[In reference to a national chain restaurant] *“It was almost like a community center, so . . . their bathrooms were open to everybody, which was good.”*

—65+ age group

In summary, the process of toileting was challenged by gatekeepers in schools, workplaces, and commercial spaces. Teachers, managers and store employees served as gatekeepers. In commercial spaces, participants described a range of experiences where staff in those settings were either permissive or restrictive in allowing access. In each setting, gatekeepers’ actions could result in adolescent and adult women suppressing their biological need (i.e., holding their urine).

3.2. Self-Restricting Toilet Use

3.2.1. Schools

Some adolescents in secondary school and young adult women in college made decisions not to go to the bathroom to maximize learning opportunities. Presumably, external expectations to focus on schoolwork were internalized resulting in decisions to not use the toilet:

“Like at school, when I don’t want to miss a certain like thing they’re going to tell us, I just kind of wait a little bit.”

—11–14 age group

“I really don’t want to miss the lesson because it’s more that I don’t know, and I don’t want to get behind. So, if I have to use the bathroom, then I’ll just wait.”

—15–17 age group

“Like, in college, I haven’t had a problem with being able to go to the bathroom but it’s just like I don’t want to miss information, in my like hour and a half long class, so I’ll sit there and then like rush to the bathroom as soon as the lecture’s over and, like, normally I should have gone but I didn’t wanna miss the information that I will probably be tested on.”

—18–25 age group

In these cases, instead of being limited by gatekeepers, adolescents and young adult women restricted their own behavior when they prioritized school work over responding to bladder cues.

3.2.2. Workplace

The notion of self-restricting use was prominent in the workplace in relation to a variety of professions and among women in a variety of age groups. This behavior was demonstrated as expectations to fulfill job responsibilities were internalized, resulting in decisions to not use the toilet:

“I worked at like a dining hall type situation and since it was me and maybe one other person, we couldn’t just leave whenever we wanted to.”

—18–25 age group

“I was working with kids, preschool teacher. So, when you got to go, you can’t run out and leave the kids.”

—45–64 age group

“Well, you’re so busy with your patients and stuff, you don’t take the time to go.”

—65+ age group

Self-restricting toilet use was even expressed by this adolescent participant when describing how she prioritized her summer job responsibilities over her need to toilet:

“When I work in the summer, I have to work with kids and you cannot leave the kids unattended, so you can’t just always put yourself first . . . working somewhere where you have to be on your feet or like interacting with people, you can’t just leave your station when you have to, like, you kind of have to put your needs and necessities on the back burner when you’re in the work setting.”

—15–17 age group

In these instances, women did not describe an external pressure from a gatekeeper to prioritize their job responsibilities; rather, foregoing a visit to the restroom and holding urine seemed to be an act of self-restricting use based on internalized workplace social norms and rules.

3.2.3. Public Spaces

Self-restricting use in public spaces was in response to perceived lack of cleanliness of public toilets, especially those not located in commercial spaces. In contrast to women’s discussion of the availability of clean and acceptable toilets in some retail establishments, porta potties and to some degree, public restrooms in parks or rest stops, were almost always portrayed as aversive, due to their lack of cleanliness, unpleasant smell, and perceived harboring of germs. These notions were manifested in language such as *“they’re so disgusting”, “gross”, “it’s just dreadful”, “they’re dirty, they stink”* and *“I feel like it’s a, like a small germ place, germ, germ filled place”*. Participants restricted their own use of toilets in response to lack of cleanliness:

“Like a dirty gas station bathroom then I can’t go.”

—18–25 age group

“I enter and that thing is in such condition, almost makes one cry, I prefer to hold it in and I turn around.”

—65+ age group

“Sometimes when you be out shopping or something and then you get the urge to go to the bathroom, you’ll find where there’s a bathroom and it’s not clean. You rather not, that’s right, you’d rather not go.”

—65+ age group

Another manner by which self-restricting use was manifested was through the internalized norm of needing to purchase goods when accessing public toilets. For example, one woman shared that she purchased goods when using public toilets in retail establishments, even when not explicitly asked to buy anything to gain access to the toilet:

“My husband and I travel a lot and we always look for fast food places because you can always go in there and use the bathroom. We usually buy a thing of iced tea because we feel bad about using the bathroom and not buying anything.”

—65+ age group

3.3. Gender Disparities in Public Toilet Access

Across their life course, participants observed differences in men’s and women’s toilet access in public spaces. They frequently recounted longer lines for women’s than men’s restrooms, believing that urinals allowed men to access toilets more efficiently.

“Even at the gas station; even at, like when you’re on a trip or something, you started to get the Stop and Go or whatever, it’s like a long line at the ladies’ room and the men’s room is like nobody, you know.”

—45–64 age group

Some adult women managed their voiding needs by using the men's restroom as an alternative to the women's restroom lines:

"I know I used the men's restroom multiple times just from the women's line just being too long and you're like yeah, I'm not going to wait, because there's no one even in the men's room, so like I know I've done that a lot of times, but I've never heard of a guy using the women's restroom."

—18–25 age group

"I go to the men's room no shame. I just scoot right in to the men's room because the men's room never has a line."

—45–64 age group

Participants discussed a variety of reasons why women's public restrooms have longer lines than men's restrooms. For example, menstruation might lead to the need for females to spend a longer time in the restroom than males:

"It does make you think, though, like why do like, of course, women have menstruation and stuff so like they might have to take care of that, but why is there longer lines for women than males?"

—18–25 age group

Adolescents and young adult women explained how it was challenging to undress while toileting, contributing to a longer time spent in the restroom. This was relevant to clothing items such as bathing suits, jumpers, dance leotards, and uniforms:

"I'm also in marching band and sometimes at football games, it's a pain to get out of our entire uniform."

—15–17 age group

This contrasted with perceptions of men's lack of clothing impediments, which facilitated easy toileting:

"They don't even have to get undressed. They, they don't. They just whip it out."

—18–25 age group

While younger women noted challenges related to clothing, among older adult women longer lines for women's toilets were attributed to LUTS, such as the need to use toilets more frequently or for a longer period of time:

"You know I always think when I was young, I said why is this women's restroom so long? The men don't have nobody in line but us women, we're always lined up at a, if it's an arena, arena or anything like that. And I did not realize that's what it was until I got older that a lot of us women have problems with our urine, the bladder."

—65+ age group

Adolescent and adult women expressed the notion that although it was acceptable for males to urinate outside or in public, females were socialized at a very early age to urinate in private. When traveling, parents of young daughters were more restrictive than parents of young sons when it came finding toileting locations for their children.

"Us as women, we cannot go just in any place. When you have a boy, you can have him pee, but not a girl."

—45–64 age group

This early socialization led to social norms that persisted later in the life course. For example, when traveling, some women chose to wait to urinate in public restrooms rather than “the side of the road” or “in the woods”.

“We can’t just pull over and pee, like we’re not dudes. We got to wait until the next rest stop, which could be miles away.”

— 15–17 age group

While participants described their observations of gender disparities in socialization about norms for privacy when using the toilet or voiding compared to males for a variety of reasons, several also described the socialization process as being unfair.

4. Discussion

This qualitative study explored U.S. adolescent and adult women’s experiences accessing toilets in schools, workplaces, and public spaces. Gatekeepers played a prominent role in controlling toilet access in school and in some occupational and public settings. Self-restricting toilet use based on internalized norms led women to balance toileting with school and job responsibilities. In public spaces, self-restricting toilet use was in response to lack of cleanliness or a perceived need to reciprocate toilet access with purchasing goods. Similar to previous studies conducted in low- and middle-income countries [29–31], we also found that, across the life course, adolescent and adult cisgender women perceived gender disparities in the ability to easily access public toilets. By using qualitative research to examine experiences across the life course, from adolescence to older adulthood, our findings point to future bladder health research needs regarding women’s toilet access in the U.S.

A striking finding in the data was the prominence of the gatekeeper in regulating adolescents’ toilet access in school settings. In contrast, gatekeepers had a more variable influence on regulating women’s toilet access in workplace settings. A few studies have described teachers serving as gatekeepers among children with urinary incontinence [32,33]; however none have described both adolescents and adult women who had attended school up to 40 years ago recalling similar experiences of having gatekeepers limit their access to toilets. This finding suggests that limited toilet access during childhood and adolescence may be a universal experience among generations of women in the U.S. Previous research has shown that young people adapt to an unpleasant school toilet environment or limited access by delaying urination and limiting fluid intake, both of which have been shown to contribute to incontinence, dysfunctional elimination and increased risk for urinary tract infection [3,7,34]. Our data suggest that most women in the U.S. may have had toilet access restrictions during childhood and adolescence, with many additionally self-restricting use based on internalized norms. Quantitative research is needed to determine the prevalence of toilet access restriction during developmental life stages of childhood and adolescence and both its immediate and long-term impact on bladder health across the life course. These data can inform future research that focuses on the development of survey instruments to identify the prevalence and correlates of gatekeeping practices within the U. S. and to examine cultural variations in the process of gatekeeping among international populations. Research also is needed to enhance our understanding of the process of gatekeeping in schools, workplaces, and other public spaces. Research has shown that U.S. teachers receive little training on how to manage voiding in school children [35–37], however a Belgian study has demonstrated that staff education about toileting is associated with improved student hydration status and increased acceptability of school toilets [38]. Thus, future public health studies are needed to determine how to best educate U.S. school gatekeepers, teachers in particular, about the important role of toilet access in maintaining bladder health.

Our study also describes the phenomenon of self-restricting toilet use in U.S. schools or workplaces, which was demonstrated by limiting one’s own use of toilets in response to internalization of external norms regarding expectations to be present for education and work tasks. A study of nurses in Australia similarly showed that nurses prioritized a work culture of “patient-first” over their own

self-care and voiding [39]; however, our data suggest that this behavior may occur across a variety of professions as well as among students. Future research is needed to understand why U.S. women may self-restrict toilet use and prioritize school and workplace responsibilities over the biologic need to urinate.

In public spaces, self-restricting use largely arose from perceived lack of cleanliness. Previous research has suggested that women and men have unique expectations when accessing public toilets, and adolescent and adult women highly value cleanliness [10,30,40,41]. Although, to our knowledge, little published research explores cisgender men's acceptance of porta-potties and public toilets, our data suggest that many public toilets are not acceptable to cisgender women, and their current availability may not improve toilet access and use in this population. Our data also suggests that the perception of lines for women's toilets may serve as a barrier to accessing women's restrooms. Some women described using men's toilets to avoid the lines, illustrating how biologic needs may override social norms regarding gender-specific bathrooms. Since U.S. adolescent and adult women perceive differences in men's and women's ability to freely access public toilets, future quantitative research is needed to determine the extent of these potential disparities in nationally representative samples of women and men in the U.S. that are geographically and demographically diverse. Of note, this study focuses on the experiences of cisgender women, and research with men or gender non-conforming or transgender individuals is also needed to understand the entire scope of issues related to toilet access disparities. The World Health Organization Sanitation guidelines view accessible sanitation as a human right, further highlighting the need to understand the extent of potential toilet access disparities in the U.S. [1].

Finally, our findings provide novel insights about the role of businesses in promoting toilet access in public spaces. Gatekeeper influences on toilet access were reflected by women's descriptions of employees requiring store purchases to access toilets. Self-restricting use was reflected by internalizing norms to purchase goods in an effort to access toilets. While it is not within the scope of this study to examine ethical or legal issues regarding businesses' toileting access practices in the U. S., we believe these data highlight the need for future research in this area. Future research and policy efforts may need to include the business community in designing accessible public toilets or in reconsidering rules about bathroom access.

This study has several limitations. By its nature, qualitative data are not designed to inform inferences about causality. Although this study included a geographically and demographically diverse sample of female individuals in the U.S., expressed perspectives may not represent the views of all subgroups of women, and future research is needed to better understand racial/ethnic differences in these perceptions and whether unique factors exist for certain ethnic groups which were not highly represented in the sample (e.g., American Indian/Native American, Asian, Native Hawaiian, and other Pacific Island women). Further, the specific barriers to toilet access identified in our study may or may not be applicable to women living in countries other than the U.S. Finally, our findings regarding toilet access are based on adolescent and adult cisgender women's voices only. Research with men or gender non-conforming or transgender individuals may yield different, but equally compelling accounts of gatekeepers and self-restricting toilet use.

5. Conclusions

Our findings illustrate that U.S. adolescent and adult women encounter gatekeepers and self-restrict toilet use in schools, workplaces and public places. These experiences potentially impact bladder health. Gatekeeping in school settings is similar across age cohorts, suggesting the deeply rooted and institutionalized nature of this practice. Similarly, gatekeeping in the workplace is attributed to commonly shared assumptions about the importance of prioritizing productivity over toileting needs. The notion of self-restricting toilet use speaks to the nuanced nature of toileting access and points to the complex ways that individuals interact with the toileting environment in schools, workplaces, and public spaces. These findings can inform future bladder health research aimed at understanding

and promoting healthy bladder habits and function in U.S. adolescent and adult women across the life course.

Supplementary Materials: The following are available online at <http://www.mdpi.com/1660-4601/16/18/3338/s1>, Table S1: COREQ (COnsolidated criteria for REporting Qualitative research) Checklist, Table S2: Participant Characteristics.

Author Contributions: Conceptualization, D.R.C., S.S.B., C.T.H., B.R.W., J.H.-B., A.S.J., K.B., J.N., J.F.W., A.B. and L.K.L.; Data curation, D.R.C.; Formal analysis, D.R.C., S.S.B., C.T.H. and L.K.L.; Funding acquisition, The Prevention of Lower Urinary Tract Symptoms (PLUS) Research Consortium; Investigation, D.R.C., S.S.B., C.T.H., B.R.W., J.H.-B., A.S.J., K.B., J.N. and L.K.L.; Methodology, D.R.C., S.S.B., C.T.H., B.R.W., J.H.-B., A.S.J., K.B., J.N. and L.K.L.; Project administration, K.B. and L.K.L.; Resources, D.R.C., S.S.B., C.T.H., B.R.W., J.H.-B., A.S.J., K.B., J.N., A.B. and L.K.L.; Software, D.R.C.; Validation, D.R.C., S.S.B., C.T.H. and L.K.L.; Visualization, L.K.L.; Writing—original draft, D.R.C.; Writing—review & editing, D.R.C., S.S.B., C.T.H., B.R.W., J.H.-B., A.S.J., K.B., J.N., J.F.W., A.B. and L.K.L.

Funding: The Prevention of Lower Urinary Tract Symptoms (PLUS) Research Consortium is supported by the National Institutes of Health (NIH)—National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) by cooperative agreements (grants U01DK106786, U01DK106853, U01DK106858, U01DK106898, U01DK106893, U01DK106827, U01DK106908, U01DK106892). Additional funding from: National Institute on Aging, NIH Office on Research in Women’s Health and the NIH Office of Behavioral and Social Science.

Disclaimer: The content of this paper is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Acknowledgments: Prevention of Lower Urinary Tract Symptoms (PLUS) Research Consortium Research Centers and Investigators

Loyola University Chicago—2160 S. 1st Avenue, Maywood, IL 60153-3328

Multi-Principal Investigators: Linda Brubaker, MD; Elizabeth R. Mueller, MD, MSME

Investigators: Colleen M. Fitzgerald, MD, MS; Cecilia T. Hardacker, MSN, RN, CNL; Jennifer M. Hebert-Beirne, PhD, MPH; Missy Lavender, MBA; David A. Shoham, PhD

University of Alabama at Birmingham—1720 2nd Ave South, Birmingham, AL 35294

Principal Investigator: Kathryn L. Burgio, PhD

Investigators: Cora E. Lewis, MD, MSPH; Alayne Markland, DO, MSc; Gerald McGwin, Jr., MS, PhD; Camille Vaughan, MD, MS; Beverly Rosa Williams, PhD

University of California San Diego—9500 Gilman Drive, La Jolla, CA 92093-0021

Principal Investigator: Emily S. Lukacz, MD

Investigators: Sheila Gahagan, MD, MPH; D. Yvette LaCoursiere, MD, MPH; Jesse N. Nodora, DrPH

University of Michigan—500 S. State Street, Ann Arbor, MI 48109

Principal Investigator: Janis M. Miller, PhD, ANP-BC, FAAN

Investigators: Lawrence Chin-I An, MD; Lisa Kane Low, PhD, CNM, FACNM, FAAN

University of Minnesota—3 Morrill Hall, 100 Church St. S.E., Minneapolis MN 55455

Multi-Principal Investigators: Bernard L. Harlow, PhD; Kyle D. Rudser, PhD.

Investigators: Sonya S. Brady, PhD; Haitao Chu, MD, PhD; John Connett, PhD; Melissa Constantine, PhD, M.P.Aff; Cynthia Fok, MD, MPH; Sarah Lindberg, MPH; Todd Rockwood, PhD

University of Pennsylvania—Urology, 3rd FL West, Perelman Bldg, 34th & Spruce St, Philadelphia, PA 19104

Principal Investigator: Diane Kaschak Newman, DNP, ANP-BC, FAAN

Investigators: Amanda Berry, PhD, CRNP; C. Neill Epperson, MD; Kathryn H. Schmitz, PhD, MPH, FACSM, FTOS; Ariana L. Smith, MD; Ann Stapleton, MD, FIDSA, FACP; Jean Wyman, PhD, RN, FAAN

Washington University in St. Louis—One Brookings Drive, St. Louis, MO 63130

Principal Investigator: Siobhan Sutcliffe, PhD, ScM, MHS

Investigators: Aimee S. James, PhD, MPH; Jerry L. Lowder, MD, MSc

Yale University—PO Box 208058 New Haven, CT 06520-8058

Principal Investigator: Leslie Rickey, MD

Investigators: Deepa R. Camenga, MD, MHS; Shayna D. Cunningham, PhD; Toby Chai, MD; Jessica B. Lewis, LMFT, MPhil

Steering Committee Chair: Mary H. Palmer, PhD, RN; University of North Carolina

NIH Program Office: National Institute of Diabetes and Digestive and Kidney Diseases, Division of Kidney, Urologic, and Hematologic Diseases, Bethesda, MD

NIH Project Scientist: Tamara Bavendam MD, MS; Project Officer: Ziya Kirkali, MD; Scientific Advisors: Chris Mullins, PhD and Jenna Norton, MPH

Other Acknowledgements: We thank Jordan L. Thomas, BA, and Lindsey Behlman, BA, for their role in codebook development. We are grateful to the PLUS Research Consortium research coordinators, focus group moderators, other personnel at each center, and all the adolescents and women who participated in the SHARE focus groups.

Conflicts of Interest: The authors declare no conflict of interest. The content of this paper is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References

1. World Health Organization. *Who Water, Sanitation and Hygiene Strategy 2018–2025*; World Health Organization (WHO/CED/PHE/WSH/18.03); World Health Organization: Geneva, Switzerland, 2018.
2. Brady, S.S.; Bavendam, T.G.; Berry, A.; Fok, C.S.; Gahagan, S.; Goode, P.S.; Hardacker, C.T.; Hebert-Beirne, J.; Lewis, C.E.; Lewis, J.B.; et al. The prevention of lower urinary tract symptoms (plus) in girls and women: Developing a conceptual framework for a prevention research agenda. *Neurourol. Urodyn.* **2018**, *37*, 2951–2964. [[CrossRef](#)] [[PubMed](#)]
3. von Gontard, A.; de Jong, T.P.; Badawi, J.K.; O’Connell, K.A.; Hanna-Mitchell, A.T.; Nieuwhof-Leppink, A.; Cardozo, L. Psychological and physical environmental factors in the development of incontinence in adults and children: A comprehensive review. *J. Wound Ostomy Cont. Nurs.* **2017**, *44*, 181–187. [[CrossRef](#)] [[PubMed](#)]
4. Lukacz, E.S.; Bavendam, T.G.; Berry, A.; Fok, C.S.; Gahagan, S.; Goode, P.S.; Hardacker, C.T.; Hebert-Beirne, J.; Lewis, C.E.; Lewis, J.; et al. A novel research definition of bladder health in women and girls: Implications for research and public health promotion. *J. Womens Health* **2018**, *27*, 974–981. [[CrossRef](#)] [[PubMed](#)]
5. Novotný, J.; Hasman, J.; Lepič, M. Contextual factors and motivations affecting rural community sanitation in low- and middle-income countries: A systematic review. *Int. J. Hyg. Environ. Health* **2018**, *221*, 121–133. [[CrossRef](#)] [[PubMed](#)]
6. Lundblad, B.; Hellstrom, A.L.; Berg, M. Children’s experiences of attitudes and rules for going to the toilet in school. *Scand. J. Caring Sci.* **2010**, *24*, 219–223. [[CrossRef](#)]
7. Lundblad, B.; Hellstrom, A.L. Perceptions of school toilets as a cause for irregular toilet habits among schoolchildren aged 6 to 16 years. *J. Sch. Health* **2005**, *75*, 125–128. [[CrossRef](#)] [[PubMed](#)]
8. Norling, M.; Stenzelius, K.; Ekman, N.; Wennick, A. High school students’ experiences in school toilets or restrooms. *J. Sch. Nurs.* **2016**, *32*, 164–171. [[CrossRef](#)]
9. Tatlow-Golden, M.; O’Farrelly, C.; Booth, A.; Doyle, O. “Bursting” to go and other experiences. *J. Sch. Nurs.* **2017**, *33*, 214–222. [[CrossRef](#)]
10. Palmer, M.H.; Wu, J.M.; Marquez, C.S.; Rupp, B.; Conover, M.M.; Newman, D.K. “A secret club”: Focus groups about women’s toileting behaviors. *BMC Womens Health* **2019**, *19*, 44. [[CrossRef](#)]
11. Palmer, M.H.; Willis-Gray, M.G.; Zhou, F.; Newman, D.K.; Wu, J.M. Self-reported toileting behaviors in employed women: Are they associated with lower urinary tract symptoms? *Neurourol. Urodyn.* **2018**, *37*, 735–743. [[CrossRef](#)]
12. Xu, D.; Zhu, S.; Li, H.; Gao, J.; Mou, H.; Wang, K. Relationships among occupational stress, toileting behaviors, and overactive bladder in nurses: A multiple mediator model. *J. Adv. Nurs.* **2019**, *75*, 1263–1271. [[CrossRef](#)] [[PubMed](#)]
13. Wan, X.; Wu, C.; Xu, D.; Huang, L.; Wang, K. Toileting behaviours and lower urinary tract symptoms among female nurses: A cross-sectional questionnaire survey. *Int. J. Nurs. Stud.* **2017**, *65*, 1–7. [[CrossRef](#)] [[PubMed](#)]

14. Harlow, B.L.; Bavendam, T.G.; Palmer, M.H.; Brubaker, L.; Burgio, K.L.; Lukacz, E.S.; Miller, J.M.; Mueller, E.R.; Newman, D.K.; Rickey, L.M.; et al. The prevention of lower urinary tract symptoms (PLUS) research consortium: A transdisciplinary approach toward promoting bladder health and preventing lower urinary tract symptoms in women across the life course. *J. Womens Health* **2018**, *27*, 283–289. [[CrossRef](#)] [[PubMed](#)]
15. Kamberelis, G.; Dimitriadis, G. Focus group research: Retrospect and Prospect. In *The Oxford Handbook of Qualitative Research*; Oxford University Press: New York, NY, USA, 2014; p. 315.
16. Cohen, D.; Crabtree, B. Qualitative Research Guidelines Project. July 2006. Available online: <http://www.qualres.org/index.html> (accessed on 8 September 2019).
17. Patton, M.Q. *Qualitative Research & Evaluation Methods*, 4th ed.; Sage Publications: Thousand Oaks, CA, USA, 2015.
18. Ulin, P.R.; Robinson, E.T.; Tolley, E.E. *Qualitative Methods in Public Health: A Field Guide for Applied Research*; John Wiley & Sons: San Francisco, CA, USA, 2016.
19. Low, L.K.; Williams, B.R.; Camenga, D.R.; Hebert-Beirne, J.; Brady, S.S.; Newman, D.K.; James, A.S.; Hardacker, C.T.; Nodora, J.; Linke, S.E.; et al. Prevention of lower urinary tract symptoms research consortium focus group study of habits, attitudes, realities, and experiences of bladder health. *J. Adv. Nurs.* **2019**. [[CrossRef](#)]
20. Patton, M.Q. *Qualitative Research and Evaluation Methods*, 3rd ed.; Sage Publications: Thousand Oaks, CA, USA, 2002.
21. Hebert-Beirne, J.; Low, L.K.; Burgio, K.L.; Hardacker, C.T.; Camenga, D.R.; James, A.S.; Newman, D.K.; Rudser, K.; Nodora, J. Novel (multi-level) focus group training for a transdisciplinary research consortium. *Health Promot. Pract.* **2019**, in press.
22. Coyne, K.S.; Barsdorf, A.I.; Thompson, C.; Ireland, A.; Milsom, I.; Chapple, C.; Kopp, Z.S.; Bavendam, T. Moving towards a comprehensive assessment of lower urinary tract symptoms (LUTS). *Neurourol. Urodyn.* **2012**, *31*, 448–454. [[CrossRef](#)]
23. De Gennaro, M.; Niero, M.; Capitanucci, M.L.; von Gontard, A.; Woodward, M.; Tubaro, A.; Abrams, P. Validity of the international consultation on incontinence questionnaire-pediatric lower urinary tract symptoms: A screening questionnaire for children. *J. Urol.* **2010**, *184*, 1662–1667. [[CrossRef](#)]
24. Tong, A.; Sainsbury, P.; Craig, J. Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *Int. J. Qual. Health Care* **2007**, *19*, 349–357. [[CrossRef](#)]
25. Elo, S.; Kyngäs, H. The qualitative content analysis process. *J. Adv. Nurs.* **2008**, *62*, 107–115. [[CrossRef](#)]
26. Hsieh, H.F.; Shannon, S.E. Three approaches to qualitative content analysis. *Qual. Health Res.* **2005**, *15*, 1277–1288. [[CrossRef](#)]
27. Barry, C.A.; Britten, N.; Barber, N.; Bradley, C.; Stevenson, F. Using reflexivity to optimize teamwork in qualitative research. *Qual. Health Res.* **1999**, *9*, 26–44. [[CrossRef](#)] [[PubMed](#)]
28. Holloway, I.; Galvin, K. *Qualitative Research in Nursing and Healthcare*; John Wiley & Sons: West Sussex, UK, 2017.
29. Khanna, T.; Das, M. Why gender matters in the solution towards safe sanitation? Reflections from rural india. *Glob. Public Health* **2016**, *11*, 1185–1201. [[CrossRef](#)] [[PubMed](#)]
30. Kwiringira, J.; Atekyereza, P.; Niwagaba, C.; Günther, I. Gender variations in access, choice to use and cleaning of shared latrines; experiences from Kampala slums, Uganda. *BMC Public Health* **2014**, *14*, 1180. [[CrossRef](#)] [[PubMed](#)]
31. Caruso, B.A.; Clasen, T.F.; Hadley, C.; Yount, K.M.; Haardorfer, R.; Rout, M.; Dasmohapatra, M.; Cooper, H.L. Understanding and defining sanitation insecurity: Women’s gendered experiences of urination, defecation and menstruation in rural Odisha, India. *BMJ Glob. Health* **2017**, *2*, e000414. [[CrossRef](#)] [[PubMed](#)]
32. Whale, K.; Cramer, H.; Joinson, C. Left behind and left out: The impact of the school environment on young people with continence problems. *Br. J. Health Psychol.* **2018**, *23*, 253–277. [[CrossRef](#)] [[PubMed](#)]
33. Lundblad, B.; Berg, M.; Hellstrom, A.L. Experiences of children treating functional bladder disturbances on schooldays. *J. Pediatr. Urol.* **2007**, *3*, 189–193. [[CrossRef](#)] [[PubMed](#)]
34. Vernon, S.; Lundblad, B.; Hellstrom, A.L. Children’s experiences of school toilets present a risk to their physical and psychological health. *Child Care Health Dev.* **2003**, *29*, 47–53. [[CrossRef](#)]
35. Cooper, C.S.; Abousally, C.T.; Austin, J.C.; Boyt, M.A.; Hawtrey, C.E. Do public schools teach voiding dysfunction? Results of an elementary school teacher survey. *J. Urol.* **2003**, *170*, 956–958. [[CrossRef](#)]

36. Boyt, M.A. Teachers' knowledge of normal and abnormal elimination patterns in elementary school children. *J. Sch. Nurs.* **2005**, *21*, 346–349. [[CrossRef](#)]
37. Ko, L.N.; Chuang, K.W.; Champeau, A.; Allen, I.E.; Copp, H.L. Lower urinary tract dysfunction in elementary school children: Results of a cross-sectional teacher survey. *J. Urol.* **2016**, *195*, 1232–1238. [[CrossRef](#)]
38. Michels, N.; Van den Bussche, K.; Vande Walle, J.; De Henauw, S. School policy on drinking and toilets: Weaknesses and relation with children's hydration status. *J. Nutr. Educ. Behav.* **2019**, *51*, 32–40. [[CrossRef](#)] [[PubMed](#)]
39. Pierce, H.; Perry, L.; Gallagher, R.; Chiarelli, P. Culture, teams, and organizations: A qualitative exploration of female nurses' and midwives' experiences of urinary symptoms at work. *J. Adv. Nurs.* **2019**, *75*, 1284–1295. [[CrossRef](#)] [[PubMed](#)]
40. Garn, J.V.; Caruso, B.A.; Drews-Botsch, C.D.; Kramer, M.R.; Brumback, B.A.; Rheingans, R.D.; Freeman, M.C. Factors associated with pupil toilet use in Kenyan primary schools. *Int. J. Environ. Res. Public Health* **2014**, *11*, 9694–9711. [[CrossRef](#)] [[PubMed](#)]
41. Coswosk, É.D.; Neves-Silva, P.; Modena, C.M.; Heller, L. Having a toilet is not enough: The limitations in fulfilling the human rights to water and sanitation in a municipal school in Bahia, Brazil. *BMC Public Health* **2019**, *19*, 137. [[CrossRef](#)] [[PubMed](#)]



© 2019 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).