The impact of chronic kidney disease on chronic school absenteeism

Kelsey Linde Richardson

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Jodi Smith

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Abstract

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Kelsey Linde Richardson

Chair of the Supervisory Committee:
Professor of Epidemiology
Noel Weiss MD, DrPh
Department of Epidemiology

Background: School absenteeism is an important predictor of low academic success. Children with chronic illness are at increased risk of school absenteeism due to disease-specific and psychosocial factors. The prevalence of chronic school absenteeism is not well described in the chronic kidney disease (CKD) population.

Objective: The purpose of this study was to document the frequency of chronic school absenteeism among children with mild to moderate CKD and compare this to the corresponding frequency in US children in general. We also sought to identify predictors of chronic school absenteeism in children with CKD.

Design/Methods: We analyzed baseline data obtained from the Chronic Kidney Disease in Children cohort study (CKiD). Participants included in this analysis had mild to moderate CKD and were >5 years of age at study enrollment (N=608). The outcome of interest was chronic school absenteeism, defined as ≥18 missed school days in the last year. The proportion of children with CKD and chronic school absenteeism was compared to published National Health and Nutrition Examination Survey (NHANES) data. To evaluate which clinical and demographic factors were associated with chronic school absenteeism among children with CKD, relative risks (RR) and 95% confidence intervals were estimated with Mantel-Haenszel adjustment for confounders.

Results: The overall prevalence of chronic school absenteeism among children with CKD was 17.3%, compared to 2.7% in the NHANES population (RR = 6.2, 95% CI: 4.6-8.4). A variety of demographic, socioeconomic and CKD specific factors were associated with chronic school absenteeism, including glomerular disease, bladder catheterization and acute illnesses. In addition, a higher medication burden was strongly associated with a stepwise increase in risk of chronic school absenteeism. Compared to children taking 1-4 medications, those taking 5-9 medications were 2.3 times more likely to be chronically absent. The relative risk was increased to 4.2 for those taking ≥10 medications. The relationship between medication burden and absenteeism was not confounded by CKD stage.

Conclusions: Children with CKD have a high prevalence of chronic school absenteeism, which is likely affecting their academic achievement. Some predisposing factors, such as medication burden, are potentially modifiable and warrant further study. Identifying patient characteristics associated with chronic school absenteeism potentially could allow for early detection and ultimately intervention to improve academic success among children with CKD.

Introduction:

School attendance is associated with academic success in children.[1] Early detection of children at high risk of frequent school absenteeism may allow for interventions to increase likelihood of school completion.[2] The prevalence of chronic school absenteeism in the United States, defined as missing 10% of the school days (approximately 18 days) in a single academic year, is reported to be 2-3% by the National Health and Nutrition Examination Survey.[3] Children with chronic illness have an increased risk of absenteeism and lower academic achievement compared to children in general.[4,5] School attendance in chronically ill children is associated with disease severity, disease control, physical limitations, psychological factors, and parental perception of their child's health.[6]

School absenteeism is not well described in the pediatric chronic kidney disease (CKD) population. Pediatric CKD has unique impacts on growth and development that potentially may affect school attendance beyond what is seen in other chronic diseases. Up to 25% of children less than 5 years of age with CKD have developmental delays,[7] and children with CKD are more likely to have lower academic achievement scores and lower intelligence quotient (IQ) scores than their siblings.[8] Hooper et al reported 21-40% of children with mild to moderate CKD from the CKiD study population scored at least one standard deviation below the mean on neurocognitive assessments.[9] Children with CKD-associated urologic abnormalities often have bowel/bladder incontinence and may require bladder catheterization, both of which are challenging for school-aged children[10] and have previously been shown to be associated with school absenteeism.[11]

The purpose of this study was to characterize chronic school absenteeism among US children with mild to moderate CKD and to compare the prevalence to published norms for healthy children. Additionally, we sought to identify predictors of chronic school absenteeism in children with CKD, recognizing that identification of these factors is an important first step in developing interventions to address barriers to school attendance.

Methods:

Study Design and Population:

This study is an analysis of baseline data obtained from children participating in the Chronic Kidney Disease in Children (CKiD) multicenter cohort study, with data supplied by the National Institutes of Diabetes and Digestive and Kidney Diseases (NIDDK) Central Repositories. All participating sites in the CKiD study have local institutional review board (IRB) approval, and additional IRB approval was obtained from our institution for the current analyses using de-identified data. Participants in this ongoing cohort study were enrolled between January 2005 and July 2013 from 51 clinical sites across the United States. The study enrolls children with mild to moderate CKD, with a glomerular filtration rate (GFR) of 30-90mL/min/1.73m^2, between 1-16 years of age. A more complete description of the CKiD study design and protocol has been previously published.[12] CKiD study exclusion criteria include prior dialysis, prior solid organ or stem cell transplantation, cancer or HIV diagnosis within the last year, current or recent pregnancy, enrollment in a current randomized trial, not fluent in Spanish or English, a genetic syndrome involving the central nervous syndrome, structural heart disease or profound mental retardation (Intelligence Quotient <40).

Although 860 children had been enrolled in the CKiD study at the time of this analysis, the present study was limited to children >5 years of age at the time of study enrollment (N=667). Age <6 years was an exclusion criteria given that the outcome of interest was school attendance and children <6 years of age are not routinely enrolled in school programs. A total of

608 children were included in the final analyses, after exclusion of 28 children who did not attend school outside their home and 31 children with missing school absenteeism data (Figure 1).

Exposures:

Exposure variables were selected to account for both demographic and clinical characteristics that could potentially influence absenteeism. All data were collected from the baseline CKiD study visit. Age was categorized as <11 years, 11-14 years, and >14 years of age to approximate elementary, middle and high school. Type of insurance (private versus public) and maternal education (high school or less, some college or college graduate) were included as socioeconomic indicators.

CKD specific factors including severity of CKD, type of CKD and urologic complications were evaluated. Severity of CKD was defined as an estimated glomerular filtration rate (eGFR) ≥60mL/min/1.73m^2 or <60mL/min/1.73m^2, based on the bedside Schwartz equation.[13] Only two categories of eGFR were used given the small number of participants with CKD stage 1 (N=27) and CKD stage 4 (N=61) in this cohort. Type of CKD was categorized as glomerular disease or non-glomerular disease. Non-glomerular disease included cystic, urologic and hereditary disease (excluding hereditary glomerulonephritis). Urologic data were collected from caregiver report to determine if the child had enuresis and/or required bladder catheterization and recorded as dichotomous yes/no variables.

CKD sequelae such as anemia, hyperphosphatemia, hypertension and short stature were evaluated as dichotomous variables. Determination of anemia was based on Kidney Disease Improving Global Outcomes (KDIGO) age-specific anemia guidelines.[14] For children 6-12 years of age, anemia was defined as a hemoglobin of <11.5g/dL. For children ≥13 years old, a hemoglobin cutoff of <12.0g/dL was used. KDIGO phosphorus guidelines were also used for determination of hyperphosphatemia.[15] For children ≤13 years old, hyperphosphatemia was defined as a serum phosphorus measurement >6.5mg/dL. For children ≥14 years old, the cutoff was 4.5mg/dL. Hypertension was determined based on caregiver report of a hypertension diagnosis. Ambulatory blood pressure monitoring data were not available, as this test was not completed at the initial study visit. Height z-scores of -2 or less were used to identify short stature, in accordance with the KDIGO definition of short stature.[15]

The number of medications taken by each participant was used to assess medication burden, which has been recently been recognized as an important clinical characteristic in patients with CKD. Medication burden was categorized as 1-4 medications, 4-9 medications and ≥10 medications. Because previous literature has shown that frequency of medication administration may play an important role in adherence,[16] we also evaluated the association between frequency of medication administration and school absenteeism.

To capture the impact of acute illnesses on school absenteeism, data on urinary tract infection (UTI), hospitalizations and emergency department visits in the last year were also collected. These data were based on parental/caregiver report and were evaluated in a separate analysis, given the ambiguous temporality with respect to school absenteeism during the prior year.

Outcome:

School attendance in the CKiD study was based on caregiver/parent recall, by asking "During the past school year, approximately how many days has (*name of child*) missed from school because of not feeling well?" The answer was recorded as the number of days missed. Children were categorized as "chronically absent" if ≥18 days of school were missed in the last year. Children were categorized as not chronically absent if <18 days of school were missed in the last year. This decision was made to align with other published school absenteeism data.[3]

Data Analysis:

Stata version 12.0 was used for all analyses. The proportion of children with ≥18 days of school missed in the last year was reported. To compare the proportion of children with CKD and chronic school absenteeism to the proportion of children studied in NHANES with chronic absenteeism, a chi-square test was used. We estimated relative risks (RR) and 95% confidence intervals to evaluate which variables were related to chronic school absenteeism in our study population. Univariate analyses were performed to assess the relationship of each demographic and clinical factor to chronic school absenteeism. We evaluated for potential confounding by both demographic and clinical variables. Only those variables that changed our risk estimate by at least 10% were accounted for with Mantel-Haenszel adjustment. Where confounding was present, both crude and adjusted risk estimates were reported.

Relative risks and 95% confidence intervals were also estimated to evaluate the relationship between chronic school absenteeism and the presence of acute illnesses (UTI, hospitalization and emergency department visits) during the prior year. We did not know when during the year school absenteeism and the exposures occurred, so could not determine whether a given day of absenteeism occurred during the illness or hospitalization. Nonetheless, in one analysis of the association between the occurrence of UTIs and chronic absenteeism, we adjusted for the occurrence of hospitalization. Both crude and adjusted estimates were reported.

Results:

The overall prevalence of chronic school absenteeism among children with CKD was 17.3% (n=105), in contrast to 2.7% of children in the NHANES population (Table 1) (RR=6.2, 95% CI: 4.6-8.4). Characteristics of children with CKD in whom chronic absenteeism was and was not present are presented in Table 2.

Univariate analyses of the associations between demographic/socioeconomic variables and chronic school absenteeism are presented in Table 3. Neither age nor race/ethnicity was related to chronic school absenteeism. Boys experienced less chronic absenteeism than girls (RR = 0.65, 95% CI: 0.46-0.91). Among children with CKD whose mother obtained a college degree, the risk of chronic school absenteeism was 0.52 times that of children whose mother obtained a high school degree or less (95% CI: 0.33-0.83). The relationship between insurance carrier and chronic school absenteeism was confounded by maternal education; after adjustment, children covered by public insurance had a 70% increased risk of chronic school absenteeism (95% CI: 20%-140%).

The associations between CKD characteristics (such as severity, etiology and sequelae of CKD) and chronic school absenteeism are shown in Table 4. There was little association between CKD severity and chronic school absenteeism. Glomerular CKD was associated with more chronic school absenteeism than non-glomerular CKD (RR=1.6, 95% CI: 1.1-2.2). There was no association between hyperphosphatemia and chronic school absenteeism; however, 50% of participants were missing hyperphosphatemia data (missing data were equally distributed between chronic absenteeism groups). In a crude analysis, short stature was associated with chronic school absenteeism; however, this relationship was somewhat attenuated when adjusted for insurance carrier.

The risk of chronic school absenteeism was higher among participants with urologic issues, specifically enuresis or the need for bladder catheterization. Both variables had a substantial amount of missing data (24% among the chronic absenteeism group, 35% among children without chronic absenteeism). The risk of chronic absenteeism was 60% higher among participants with documented enuresis (95% CI: 1.0-2.4). When adjusted for type of CKD, the risk of chronic school absenteeism was 2.2 times higher among children requiring bladder catheterization (95% CI: 1.4-3.7). Given the elevated risk of UTI in children with enuresis or bladder catheterization, we repeated this analysis with adjustment for the presence of UTI in the last year. This adjustment attenuated both risk estimates, with an adjusted relative risk of 1.5 for enuresis (95% CI: 0.98-2.3) and an adjusted relative risk of 1.6 for bladder catheterization (95% CI: 0.84-3.2).

There was a strong relationship between higher medication burden and chronic school absenteeism. When compared to a baseline category of 1-4 medications, children requiring 5-9 medications had 2.9 times the risk of chronic school absenteeism (95% CI: 1.6-3.4) and children requiring ≥10 medications had 4.2 times the risk (95% CI: 2.6-6.7). To evaluate if medication burden was a marker of disease severity, the relationship between medication burden and chronic school absenteeism was adjusted for GFR category, but this did not appreciably alter risk estimates. Children requiring medication administration at least twice per day were 2.6 times as likely to be chronically absent from school, compared to those requiring once per day dosing (95% CI: 2.4-5.1). There was not a stepwise increase in absenteeism as medication frequency increased beyond twice per day. Adjustment for frequency of medication administration had only a modest effect on the relationship between medication burden and chronic absenteeism.

A history of acute illnesses was also positively associated with chronic school absenteeism. Study participants with at least one UTI in the last year had an increased risk of chronic school absenteeism compared to those with no such infections. This relationship remained present after adjusting for a history of hospitalization in the last year, to account for any effect from hospitalization for diagnosis and/or treatment of the infection. A history of hospitalization (any reason) within the last year was associated with a 4.1 times higher risk of chronic school absenteeism (95% CI: 2.9-5.8). Children with CKD who had one emergency room visit in the last year also demonstrated increased risk of chronic school absenteeism (RR = 2.9, 95% CI: 1.7-4.9); the corresponding relative risk among children with >1 emergency room visit was 5.8 (95% CI: 3.8-8.7) (Table 5).

Discussion:

Children with CKD have a higher frequency of chronic school absenteeism than United States children in general. As pediatric providers we counsel families on the long term impacts of chronic illness, but influences on education are not commonly discussed.[17,18] School absenteeism is an important issue given the association with decreased academic achievement.[2,11] Educational outcomes in adults with childhood-onset CKD are poor[19], and chronic absenteeism is likely contributing to lower achievement. Additionally, school attendance is closely linked to social functioning in children, with school absenteeism potentially characterizing children with lower quality of life.[4,6]

We identified several predictors of school absenteeism among children with CKD, including demographic, socioeconomic and disease specific indicators. While these exposures and characteristics are not necessarily modifiable or causal, they may permit the identification of at-risk children. Surprisingly, there was no association between chronic school absenteeism and severity of renal disease, which may be due to the limited GFR range of participants in this study population. However, studies of other complex outcome measures, such as health related quality of life among children with CKD, have also failed to demonstrate an association with disease severity.[20,21] In contrast, Duquette et al demonstrated that lower GFR was associated with a higher risk of grade retention and increased school absenteeism, among a sample of 30 children with CKD.[22]

Some of the factors associated with chronic school absenteeism that we identified are related to disease control (such as medication burden) and/or the occurrence of acute illnesses. These findings are similar to studies in other chronic disease populations, such as children with asthma and lupus, where school absenteeism has been associated with disease control.[23,24] Asthma literature suggests that the association between absenteeism and the intensity of disease management may be useful not only to identify children at risk for school failure, but to identify children with sub-optimal disease control based on the number of missed school days.[23,25]

The association between medication burden and chronic school absenteeism provides a potentially modifiable exposure. Medication burden is not only a surrogate of disease severity; it likely is an indicator of relatively poor disease control as well. For example, previous studies have shown that that complex pill regimens are associated with lower levels of medication adherence.[16,26] Regardless of the mechanism driving the association between medication burden and absenteeism, it can be used as an identifier of patients at risk for chronic school absenteeism. This relationship should be further studied to understand if medication burden is a possible target for interventions to address school absenteeism.

This is one of the first studies of school absenteeism in the chronic kidney disease population and provides insight into the scope of the problem among patients with CKD. Although the frequency of chronic school absenteeism is striking in the CKD population, these findings are likely an underestimate. The method of outcome ascertainment in this study probably underrepresents the true burden of chronic illness on school attendance, as it does not capture partial missed days for clinic appointments and does not account for time out of the classroom for school nurse visits, medication administration or catheterization. Given the cross-sectional nature of this study, temporality and causality are difficult to determine. This is most problematic when evaluating associations between school absenteeism and a history of acute illnesses, since these events occurred over the same time period as school absenteeism assessment. However, since even those individuals with only one emergency visit had a higher risk of chronic school absenteeism, these relationships are likely mediated by more than just the actual time spent in the hospital or emergency room. Future study should be targeted at longitudinal assessment of absenteeism in children with CKD to clarify the significance of this association.

Healthcare providers may have a limited view of patients' lives outside of the hospital or clinic setting. Asking about school attendance provides insight into how children and families are coping with chronic illness and is something many patients and caregivers want to discuss.[17] Identifying patients with chronic absenteeism is the first step to developing interventions to improve academic success. Enhanced communication between educators and clinicians could allow for a shared understanding of how to support children with complex health care needs.[27–29] Health care providers also need to better understand school resources and parental concerns regarding the school's ability to recognize and manage a medical issue during the school day.[25] As healthcare teams, we need to understand barriers to school attendance in order to develop appropriate targeted interventions to help children attend school and succeed in the classroom.

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Table 1. Frequency of chronic school absenteeism in NHANES population compared to CKiD study population

	Missed School Days					
	≥18		<18		Relative Risk	
	n	(%)	n	(%)	RR	(95% CI)
NHANES	60	(2.7)	2105	(97.2)	1.0	Referent
CKiD	105	(17.3)	503	(82.7)	6.2	(4.6 – 8.4)

NHANES = National Health and Nutrition Examination Survey, CKiD = Chronic kidney disease in children study, CI = confidence interval

Table 2. Demographic and clinical characteristics of children with chronic kidney disease, by chronic school absenteeism (≥18 days missed) status in the previous year

	Missed School Days			
	≥18 (N=105)		<18 (N=503)	
	n[a]	(%)	n[a]	(%)
Age (years)				
<11	40	(19.4)	166	(80.6)
11-14	36	(16.7)	180	(83.3)
>14	29	(15.6)	157	(84.4)
Gender				
Female	51	(21.2)	179	(77.8)
Male	54	(14.3)	324	(85.7)
Insurance				
Private	50	(13.4)	324	(86.6)
Public	51	(25.5)	149	(74.5)
Race/Ethnicity				
Caucasian/Non-Hispanic	57	(16.6)	286	(83.4)
Caucasian/Hispanic	7	(11.7)	53	(88.3)
African-American	19	(17.0)	93	(83.0)
Other	22	(24.7)	67	(75.3)
Maternal Education				
High School or Less	48	(21.0)	181	(79.0)
Some College	33	(20.1)	131	(79.9)
College Graduate	22	(10.9)	179	(89.1)
eGFR (mL/min/1.73m^2)				
≥60	43	(19.8)	174	(80.2)
<60	62	(15.9)	329	(84.1)
CKD Etiology				
Glomerular	44	(22.8)	149	(77.2)
Non-Glomerular	61	(14.7)	354	(85.3)
Enuresis[b]				
No	42	(12.5)	294	(87.5)
Yes	26	(23.2)	86	(76.8)
Catheterization[b]				
No	45	(12.4)	319	(87.6)
Yes	23	(26.1)	65	(73.9)
Anemia				
No	66	(14.6)	386	(85.4)
Yes	37	(25.7)	107	(74.3)
Hyperphosphatemia[c]				
No	43	(16.3)	220	(83.7)

	Yes	10	(25.0)	30	(75.0)
Short stature					
	No	88	(16.1)	460	(83.9)
	Yes	17	(28.3)	43	(71.7)
Hypertension					
	No	42	(14.2)	254	(85.8)
	Yes	62	(20.3)	244	(79.7)
Pill Burden[d]					
	1 to 4	39	(11.2)	310	(88.8)
	5 to 9	47	(25.7)	136	(74.3)
	≥ 10	16	(47.1)	18	(52.9)

CKD = Chronic kidney disease, eGFR = Estimated glomerular filtration rate, UTI = Urinary tract infection

All variables have <5% missing data unless otherwise noted

[a] Numbers may not add up to total due to missing data

[b] Variable has 24% missing data in chronic absenteeism group and 35% missing data in group without chronic absenteeism

[c] 50% missing data in each group

[d] Pill burden represents number of unique medications reported by participant/caregiver; 2.9% missing data in group with chronic school absenteeism, 7.8% missing data in group without chronic school absenteeism

Table 3. Crude and adjusted associations between demographic characteristics and chronic school absenteeism

	Crude RR	95% CI	Adjusted RR	95% CI
Age (years)				
<11	1.0	Reference	-	-
11-14	0.86	0.57-1.3	-	-
>14	0.80	0.52-1.2	-	-
Gender				
Female	1.0	Reference	-	-
Male	0.65	0.46-0.91	-	-
Insurance[a]				
Private	1.0	Reference	1.0	Reference
Public	1.9	1.3-2.7	1.7	1.2-2.4
Race/Ethnicity				
Caucasian/Non-Hispanic	1.0	Reference	-	-
Caucasian/Hispanic	0.70	0.34-1.5	-	-
African American	1.02	0.64-1.6	-	-
Other	1.5	0.96-2.3	-	-
Maternal Education				
High school or less	1.0	Reference	-	-
Some college	0.96	0.65-1.4	-	-
College graduate	0.52	0.33-0.83	-	-

RR = relative risk, CI = confidence interval

[a] Adjusted for maternal education

Table 4. Crude and adjusted association between chronic kidney disease characteristics and chronic school absenteeism

		Crude RR	95% CI	Adjusted RR	95% CI
eGFR (mL/min/1.73m²)					
	≥60	1.0	Reference	-	-
	<60	0.80	0.56 – 1.1	-	-
Etiology					
	Non-Glomerular	1.0	Reference	-	-
	Glomerular	1.6	1.1-2.2	-	-
Anemia[a]					
	No	1.0	Reference	1.0	Reference
	Yes	1.8	1.2-2.5	1.6	1.1-2.3
Hyperphosphatemia					
	No	1.0	Reference	-	-
	Yes	1.5	0.84-2.8	-	-
Short Stature[a]					
	No	1.0	Reference	1.0	Reference
	Yes	1.8	1.1-2.8	1.5	0.99-2.4
Hypertension					
	No	1.0	Reference	-	-
	Yes	1.4	1.0-2.0	-	-
Enuresis					
	No	1.0	Reference	-	-
	Yes	1.6	1.0-2.4	-	-
Catheterization[b]					
	No	1.0	Reference	1.0	Reference
	Yes	1.9	1.2-3.0	2.2	1.4-3.7
Medication Burden					
	1 to 4	1.0	Reference	-	-
	5 to 9	2.3	1.6-3.4	-	-
	≥ 10	4.2	2.6-6.7	-	-

eGFR = estimated glomerular filtration rate, CKD = chronic kidney disease, RR = relative risk, CI = confidence interval

[a] Adjusted for insurance carrier

[b] Adjusted for type/etiology of kidney disease (glomerular v. non-glomerular)

Table 5. Crude and adjusted associations between UTI, hospitalization or emergency room visits in the last year with chronic school absenteeism

	Missed School Days ≥18		Missed School Days <18		Crude Relative Risk		Adjusted Relative Risk	
	n	(%)	n	(%)	RR	95% CI	RR	95% CI
≥1 UTI[a]								
No	79	(77.5)	445	(89.2)	1.0	Reference	1.0	Reference
Yes	23	(22.6)	54	(10.8)	2.0	1.3-2.9	2.5	1.6-3.8
Hospitalization								
No	43	(41.4)	406	(81.0)	1.0	Reference	-	-
Yes	61	(58.6)	95	(19.0)	4.1	2.9-5.8	-	-
Emergency visits								
None	29	(29.9)	359	(72.2)	1.0	Reference	-	-
1	21	(21.7)	76	(15.3)	2.9	1.7-4.9	-	-
>1	47	(48.5)	62	(12.5)	5.8	3.8-8.7	-	-

UTI = urinary tract infection, RR = relative risk, CI = confidence interval
[a] Adjusted for type/etiology of CKD (glomerular v. non-glomerular)

Figure 1. Flow diagram of patient inclusion in study population