

# Medication adherence in pediatric renal transplant patients: The role of family functioning and parent health locus of control

Meghan Marie Kraenbring<sup>1,2</sup>  | Nataliya Zelikovsky<sup>1,3</sup> | Kevin E. C. Meyers<sup>3</sup>

<sup>1</sup>Psychology Department, La Salle University, Philadelphia, Pennsylvania

<sup>2</sup>Department of Child and Adolescent Psychiatry and Behavioral Science, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania

<sup>3</sup>Division of Nephrology, Department of Pediatrics, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania

## Correspondence

Meghan Marie Kraenbring, Department of Child and Adolescent Psychiatry and Behavioral Science, Children's Hospital of Philadelphia, Philadelphia, PA.  
Email: kraenbrinm@email.chop.edu

## Funding information

Novartis

## Abstract

Children and adolescents with renal disease experience daily social, emotional, and medical challenges. Renal transplantation can help to improve quality of life but requires a lifelong regimen of immunosuppressant medication to maintain health. Adherence to a daily complex regimen can be difficult, particularly for adolescents who are beginning to develop autonomy from caregivers and are faced with a unique set of socio-emotional challenges. This study examines two factors that have shown to influence adherence in other pediatric populations, namely family functioning and parent health locus of control, from mothers' perspectives, in predicting medication non-adherence for adolescents (ages 12-19 years) 1 year post-transplant. Non-adherence was defined as the percentage of missed doses and late doses of the weekly immunosuppressant doses prescribed. Regression results demonstrated that mothers' perceptions of poorer overall family functioning predicted missed medication doses ( $\Delta R^2 = 0.383$ ,  $F(7, 21) = 2.570$ ,  $P = 0.044$ ) with significant contributions in the domains of problem-solving ( $\beta = -0.795$ ,  $t(21) = -2.927$ ,  $P = 0.008$ ) and affective involvement ( $\beta = 0.872$ ,  $t(21) = 3.370$ ,  $P = 0.003$ ). Moreover, mothers who perceived that their adolescent had control over his/her health also predicted more missed medication doses ( $\Delta R^2 = 0.133$ ,  $F(1, 27) = 5.155$ ,  $P = 0.031$ ). Important implications for these findings include implementation of family-based interventions that promote developmentally appropriate skills for adolescents and cultivate emotional involvement within the family.

## KEYWORDS

adherence, adolescents, family functioning, parents, renal transplantation

## 1 | INTRODUCTION

RRT is required when renal function is less than 15% due to ESKD. A kidney transplant is typically the recommended treatment option

to improve quality of life, promote better outcomes, achieve typical developmental milestones, attain desired adulthood roles, and reduce the potential for mortality.<sup>1</sup> Despite its positive benefits, kidney transplantation poses life-long challenges to children and their families.<sup>2,3</sup> Adherence to a stringent regimen of immunosuppressant medications is essential for graft survival<sup>4</sup> and optimizing quality of life post-transplant.<sup>5</sup> Poor adherence can lead to medical complications such as acute rejection, graft loss, and mortality.<sup>2</sup>

**Abbreviations:** ANOVA, analysis of variance; ESKD, end-stage kidney disease; FACES, Family Adaptability and Cohesion Scale; FAD, family assessment device; HLOC, health locus of control; IBD, inflammatory bowel disease; IRB, institutional review board; MAM, medical adherence measure; M, mean; PHLOC, parent health locus of control; RRT, renal replacement therapy; SD, standard deviation; UNOS, United Network for Organ Sharing.

Non-adherence is typically defined as the extent to which patients miss, forget, alter, or delay their medication.<sup>6</sup> Non-adherence prevalence rates in pediatric renal transplant recipients are strikingly high, with prevalence rates ranging from 30% to 80%.<sup>7-9</sup> To this end, multiple factors (eg, cognitive, social, developmental, psychological, systemic) impact post-transplant adherence.<sup>10-12</sup> According to Johns Hopkins Pediatric Transplant Center, two relative contraindications for receiving a kidney transplant are “lack of family or social support” and “evidence of significant non-adherence.”<sup>13</sup> Thus, identifying key factors leading to non-adherent behavior can be beneficial for children, families, and the healthcare system at large.

The family system as a whole can be affected by caring for a chronically ill child, with 13%-36% of families endorsing functioning in the unhealthy range.<sup>14</sup> Multiple areas of family functioning can be affected and have overt effects on the children's medical adherence, including communication, cohesion, emotional expressiveness, conflict, problem-solving, coping style, adaptation, behavioral control, affective involvement, and division of responsibilities.<sup>14-20</sup> In fact, medication adherence in pediatrics requires high levels of familial involvement.<sup>21</sup> A meta-analysis in 2010 found that family functioning, particularly greater parental distress and lower family cohesion, was significantly related with poorer adherence across pediatric solid organ transplant groups.<sup>1</sup> Likewise, it has been suggested that low familial efficacy and low flexibility are related to increased barriers to adherence, while increased parental involvement promoted adherence among kidney transplant patients.<sup>11,12</sup> A more recent meta-analysis found that in pediatric solid organ transplant populations, a family environment with high stability, greater perceived support, and high emotional expressiveness led to greater adherence.<sup>22</sup> Therefore, family environments that are not overly rigid or chaotic, but instead are adaptable and capable of planning and making informed decisions, and are emotionally present, promote adherence in adolescents. Thus, the literature provides evidence that the family environment plays an important role in adolescent adherence. Yet, there has been little attention to family variables that may contribute to health behaviors, such as affective involvement, communication, division of responsibilities, behavioral control, and problem-solving, particularly in pediatric renal transplant patients.

PHLOC, or parents' appraisal of their control over their child's health outcomes, has also been found to contribute to adherence in pediatric populations, including epilepsy, sickle-cell disease, and orthopedic conditions. Parents with high internal PHLOC ascribe their child's health outcomes to their own parenting efforts.<sup>23</sup> However, parents who believe that their child's health is controlled by outside forces, including powerful others (eg, doctors, medical staff) and chance endorse high external PHLOC.<sup>23</sup> External PHLOC has been related to greater illness knowledge, which then predicted better adherence in pediatric epilepsy patients<sup>24</sup> and better treatment outcomes for patients with pediatric overweight,<sup>25</sup> likely due to a stronger patient-physician relationship. In the same study of patients with pediatric overweight, internal PHLOC was associated with poorer adherence, indicating that parents who feel responsible for their child's treatment may

be less open to provider recommendations or may unintentionally exhibit excessively controlling behaviors that are counter-productive to treatment.<sup>25</sup> Moreover, in a pediatric liver transplant population, a positive correlation was found between parents who perceived that their child had more responsibility over his/her health and better adherence.<sup>26</sup> Conversely, other research has shown that internal PHLOC is related to better adherence. Specifically, one study suggested that parents who are self-reliant and exhibit an internal sense of control may be more confident in their ability to adhere to the medical recommendations for their child.<sup>27</sup> In addition, internal PHLOC has been associated with higher adaptability, better problem-solving within the context of medical management, and fewer behavioral and emotional difficulties in pediatric patients with sickle-cell disease, cerebral palsy, seizure disorders, and orthopedic conditions.<sup>28,29</sup> Unfortunately, studies examining PHLOC and its impact on illness management are scarce, and findings have been mixed depending on the medical condition examined.

In conclusion, prior research has shown that healthy family functioning is associated with increased adherence in renal transplant patients. However, there has been limited research examining the impact of the following family functioning variables on adherence: problem-solving, communication, division of responsibilities, affective involvement, and behavioral control. Thus, the first aim of this study was to examine whether mothers' perception of high family functioning in these domains would predict fewer missed and late doses for adolescent kidney transplant recipients. Additionally, both internal and external PHLOC contribute to adherence in chronically ill populations, whether to interfere or promote illness management. However, PHLOC has not been evaluated in the pediatric transplant literature. Because the findings have been mixed in other populations, it is not possible to draw firm conclusions about the influence of PHLOC on health behaviors or to generalize the findings to pediatric transplant patients. Therefore, the second aim of this study sought to examine the role of PHLOC in adherence, hypothesizing that internal PHLOC would predict fewer missed and late doses for adolescent kidney transplant recipients.

## 2 | PATIENTS AND METHODS

### 2.1 | Participants and methods

Fifty adolescents aged 12-19 years ( $M = 15.67$ ;  $SD = 2.16$ ) and their mothers were recruited 1 year post-renal transplant at the Children's Hospital of Philadelphia. They were required to have the ability to read English at a fifth-grade reading level. This study utilized archival data collected as part of a larger longitudinal study examining psychological predictors of adherence among adolescent transplant patients, which was funded by a pharmaceutical grant. The study was approved by the IRB at the Children's Hospital of Philadelphia and conducted in accordance with good clinical practice.

**TABLE 1** Demographics

	Frequency (%)
Sex	
Female	25
Male	75
Race	
Caucasian	63.3
African American	23.3
Asian	2.0
Hispanic	5.0
Biracial	1.0
Mother education level	
Junior high school	1.7
Some high school (10th-11th)	8.3
High school graduate/GED	30.0
Partial college/specialized training	25.0
Standard college	26.7
Graduate/professional degree	5.0
Income	
Less than \$30 000	20.3
Between \$30 000 and \$60 000	32.7
Greater than \$60 000	34.7
Maternal marital status	
Married to/living with biological parent	63.3
Remarried/living with stepparent	21.7
Divorced/living alone	8.3
Living with non-bio parent	5.0

## 2.2 | Measures

*Family Demographic Information* included ethnicity, type of transplant, marital status, religion, child and parent(s) education level, family income, parent(s) occupation, and family composition.

*Medical Information Form* was used to gather adolescents' medical history including medication regimen, laboratory data, diagnosis, age of diagnosis, age adolescents were listed for a transplant and age at the time of transplant, and type of organ needed for transplant.

*The FAD*<sup>30,31</sup> is a 60-item self-report measure that assesses family functioning based on the McMaster Model of Family Functioning. The FAD consists of seven subscales: Problem Solving, Communication, Roles, Affective Responsiveness, Affective Involvement, Behavior Control, and General Functioning. Lower scores indicate healthier functioning. The FAD has a good to excellent reliability and construct validity, with internal consistencies of 0.72-0.92, test-retest reliabilities of 0.66-0.76, and content validity above 0.50 with two other family functioning measures, the FACES II and the Family Unit Inventory.<sup>31,32</sup> In this study, the FAD exhibited good internal consistency: Problem Solving ( $\alpha = 0.767$ ), Communication ( $\alpha = 0.672$ ), Roles ( $\alpha = 0.760$ ), Affective Responsiveness ( $\alpha = 0.728$ ), Affective

Involvement ( $\alpha = 0.758$ ), Behavior Control ( $\alpha = 0.855$ ), and General Functioning ( $\alpha = 0.872$ ).

*MAM*<sup>12,33</sup> is a semistructured interview assessing knowledge about medical regimen, adherence behavior, organizational plan to manage one's medical regimen, and perceived barriers to adherence over the past 7 days. The MAM measures three areas of specific adherence behaviors, including medication administration/usage, diet, and clinic attendance. Only the medication module was used for the purpose of this study to assess adherence to immunosuppressant medications. Adherence summary scores were calculated as the percentages of medication dosages "taken," "missed," and "late" out of prescribed weekly doses. The MAM also asks if the patient manages medication independently or if any individuals are responsible for the adolescent's medication management (ie, parent, sibling), and the responses are coded as a continuous variable to indicate how many adults provide assistance (eg, 0, 1, 2). The MAM demonstrated good convergent validity with electronic monitoring devices. In preliminary studies with pediatric renal transplant candidates, the percentage of missed doses endorsed on the MAM was significantly correlated with the missed doses tracked by electronic monitoring ( $r = 0.40, P = 0.04$ ).<sup>12</sup> This was also documented in a 2010 systematic review assessing adherence in the pediatric kidney transplant population.<sup>7</sup> Another study found that parent reports of adherence on the MAM were modestly correlated with serum assay measures of adherence in a pediatric IBD sample.<sup>34</sup> The MAM has demonstrated good predictive validity demonstrating associations with mortality and acute rejection episodes 2 years post-renal transplant ( $r = 0.62, P < 0.001$ ) and adequate test-retest reliability ( $r = 0.89, P < 0.05$ ).<sup>12,33</sup>

A semi-structured interview was selected for this study to examine the intricacies of adherence (eg, degree of missed vs. late timing in medication dosages) in relation to adolescents' functioning, in order to better understand patterns of adherence behaviors rather than a dichotomized measure of adherence in the form of yes/no self-report questions. Self-report assessments of adherence have been shown to be more accurate when individuals are asked to recall data regarding specific behaviors (eg, "How many times did your child take this medication per day, on average?") within shorter intervals (eg, the past week).<sup>35</sup> Shi et al<sup>36</sup> found that electronic medication monitoring devices were moderately to highly correlated with self-report measures of adherence.

*PHLOC* measure<sup>37</sup> is a 30-item questionnaire used to assess parents' beliefs about the health of their child. Subscales assess how influential parents believe the following are regarding their child's health: Child, Divine, Fate, Media, Parental Influences, and Professional Influences. Responses are rated on a 6-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). Internal consistency reliabilities range from 0.70 to 0.84 and test-retest correlations were all above 0.60 for all subscales.<sup>37,38</sup> Findings demonstrate good validity.<sup>37</sup> The current study utilized only the Child, Fate, Parental Influences, and Professional Influences subscales. Reliability in this sample suggested strong internal consistency: Professionals ( $\alpha = 0.740$ ), Parents ( $\alpha = 0.885$ ), Child ( $\alpha = 0.839$ ), and Fate ( $\alpha = 0.937$ ).

### 3 | RESULTS

#### 3.1 | Sample and descriptive statistics

The sample was largely male (73.5%) and Caucasian (63.3%) with the second largest group being African American (23.3%). Mothers' attained education level ranged from junior high school to a graduate/professional degree. There was a range of family income, with about one-third of families falling in the lower, middle, and upper income category. Table 1 summarizes demographic data. The age of participants at time of diagnosis varied from 0 (birth) to 17.25 years ( $M = 5.36$  years;  $SD = 5.80$ , median 2.92 years). Adolescents waited on the UNOS transplant list 0 to 60 months ( $M = 15.62$  months;  $SD = 13.76$  months), 40.8% received a living related transplant, and 63.3% were on dialysis prior to transplant. The mean age at time of transplant was 14.94 years with a  $SD$  of 2.24 years. Regarding responsibility of medication management, 16 out of 50 adolescents endorsed managing their medication independently, while 34 out of 50 adolescents endorsed having at least one caregiver (mother, father, and/or grandparent) involved in medication management.

To determine whether there were significant relationships between any demographic or medical variables, and the main variables of interest (family functioning, PHLOC, and non-adherence),  $t$ -tests, one-way ANOVAs, and correlational analyses were conducted to account for dichotomous, categorical, and continuous variables. Current age of the child was significantly related to missed doses ( $r = 0.333$ ,  $P = 0.038$ ), and income was significantly related to late doses ( $F(11, 41) = 5.23$ ,  $P < 0.01$ ). Caregiver involvement in medication management was significantly positively correlated with the FAD subscale Roles ( $r = 0.411$ ,  $P = 0.005$ ) and negatively correlated with missed doses ( $r = -0.347$ ,  $P = 0.013$ ). The other demographic and medical variables and subscales of the FAD and PHLOC were not related to non-adherence.

#### 3.2 | Family functioning

The first hypothesis was examined utilizing a hierarchical multiple regression to determine the role of family functioning in predicting adolescent non-adherence, as perceived by mothers. Assumptions of multiple regressions were met with the exception of multicollinearity, consistent with the FAD model that posits the interrelatedness of family functioning areas. Non-adherence was measured by two separate scores, calculated as the adolescents' reported missed doses or late doses divided by the number of prescribed doses documented in their chart. The decision to separate missed and late doses was based on the transplant literature demonstrating that both types measure different facets of adherence, yet both can result in severe consequences.<sup>39</sup>

Demographic variables (ie, age of child and income) were entered into the first step of the regression based on theory positing that developmental age and family resources can impact adherence. Research has demonstrated that older adolescents<sup>4,22</sup> and lower

income families<sup>21,22</sup> exhibited greater non-adherence. The current sample supports this relationship, as the age of the child was significantly related to missed doses and income level to late doses. Caregiver involvement in medication management was also added to the first step, given that it was significantly correlated with the Roles subscale of the FAD and missed doses. In the second step, all seven subscales of the FAD were entered together based on the McMaster Model of Family Functioning, which posits that all parts of the family system are interrelated, cannot be viewed in isolation, and interact to shape behavior over time.<sup>40</sup> The current sample supports this model as the majority of subscales were significantly correlated ( $r$  ranging from 0.397 to 0.801). Mothers' perception of family functioning was found to be a statistically significant predictor of missed doses of immunosuppressant medication after controlling for the child's age, income, and caregiver involvement in medication management ( $\Delta R^2 = 0.383$ ,  $F(7, 21) = 2.570$ ,  $P = 0.044$ ).

In particular, Problem Solving significantly contributed to the overall model ( $\beta = -0.795$ ,  $t(21) = -2.927$ ,  $P = 0.008$ ), demonstrating an inverse relationship with adherence. That is, when mothers perceive the family to engage in more problem-solving (ie, lower score indicative of fewer problems or better functioning), adolescents tend to miss more doses (ie, higher non-adherence score). Moreover, Affective Involvement explained a statistically significant portion of the variance in missed doses ( $\beta = 0.872$ ,  $t(21) = 3.370$ ,  $P = 0.003$ ), suggesting that when mothers perceive that family members are less emotionally involved with each other (ie, higher score indicative of more problems), adolescents miss more doses. Mothers' perception of family functioning was not a significant predictor of late doses (Table 2).

#### 3.3 | PHLOC

To examine the role of PHLOC in predicting non-adherence, a total of eight separate multiple regressions were conducted. The first four utilized the four PHLOC subscales with missed doses as the dependent variable and the second four utilized the four PHLOC subscales with late doses. The decision to run eight separate multiple regressions was made based upon research that the HLOC dimensions are distinct factors.<sup>41</sup> As such, individuals with renal transplant have been shown to endorse both high internal and external HLOC.<sup>42</sup> Age of child, income, and caregiver involvement in medication management were again entered into the first step of all regressions, while each PHLOC subscale was entered in step two (ie, Parental Influences, Child, Professional Influences, and Fate). The remaining PHLOC subscales (Divine and Media) were excluded from the analysis as research does not demonstrate their relationship to adherence.<sup>27,28</sup> The Child subscale was found to be a statistically significant predictor of missed doses ( $\Delta R^2 = 133$ ,  $F(1, 27) = 5.155$ ,  $P = 0.031$ ), suggesting that when mothers perceive their adolescents as having greater control over their health, adolescents miss more doses. The remaining PHLOC subscales were not significant predictors of missed doses and none of the PHLOC subscales were predictive of late doses (Table 3).

**TABLE 2** Hierarchical multiple regression analysis summary of mothers' perception of family functioning on non-adherence (n = 50)

Variable	B	SE B	$\beta$	R <sup>2</sup>	$\Delta R^2$
Regression 1: Missed doses					
Step 1: Demographic variables				0.170	0.170
Age of child	0.006	0.004	0.287		
Income	-0.001	0.003	-0.061		
Caregiver involvement	-0.001	0.012			
Step 2: Family functioning				0.553	0.383 <sup>a</sup>
Problem solving	-0.078	0.027	-0.795 <sup>b</sup>		
Communication	-0.008	0.030	-0.056		
Roles	-0.039	0.032	-0.366		
Affective responsiveness	-0.006	0.020	-0.058		
Affective involvement	0.084	0.025	0.872 <sup>b</sup>		
Behavior control	-0.004	0.028	-0.035		
General functioning	0.000	0.041	0.001		
Regression 2: Late doses					
Step 1: Demographic variables				0.019	0.019
Age of child	0.006	0.006	0.242		
Income	0.003	0.004	0.208		
Caregiver involvement	-0.008	0.019	-0.114		
Step 2: Family functioning				0.302	0.282
Problem solving	-0.043	0.041	-0.357		
Communication	0.060	0.048	0.364		
Roles	0.031	0.050	0.243		
Affective responsiveness	0.021	0.031	0.172		
Affective involvement	0.035	0.039	0.303		
Behavior control	-0.061	0.043	-0.390		
General functioning	0.035	0.064	0.207		

<sup>a</sup>P < 0.05.<sup>b</sup>P < 0.01.

## 4 | DISCUSSION

This study sought to explore the role of mothers' perception of family functioning and their beliefs about their adolescent's health in predicting medication non-adherence 1 year post-renal transplant. Mothers' perception of overall family functioning was a significant predictor of missed immunosuppressant doses, although not late doses. This finding is consistent with prior research that poor family functioning leads to greater non-adherence.<sup>1</sup> Contrary to the initial hypothesis, mothers' perception of greater problem-solving was associated with worse adherence. Though this finding was unexpected, it may be explained within the context of adolescents' developmental period. Mothers who perceive their family to be effective at problem-solving may be highly involved in their adolescents' lives offering problem-solving advice, which could in turn frustrate

adolescents who are attempting to gain autonomy. Their frustration may lead to missing doses out of resistance or rebellion rather than implementing the skills suggested by parents to enhance adherence. The types of problem-solving skills used by mothers also may not be developmentally appropriate or collaborative, reducing adolescents' ability, or likelihood of utilization. In addition, when mothers perceived high affective involvement, that is family members who value each other's concerns and are interested in their daily activities, adolescents missed fewer doses. Adolescents may find it easier to adhere to their medication regimens when family members are able to recognize, understand, and validate the emotional challenges they experience and provide emotional support. In contrast, ignoring adolescents' emotional experiences may lead to them feeling misunderstood and subsequently to non-adherence. It appears that increased parental involvement may promote adherence, but the

**TABLE 3** Hierarchical multiple regression analysis summary of mothers' HLOC on non-adherence (n = 50)

Variable	B	SE B	$\beta$	R <sup>2</sup>	$\Delta R^2$
Regression 1: Missed doses					
Step 1: Demographic variables				0.170	0.170
Age of child	0.004	0.004	0.214		
Income	0.000	0.002	-0.035		
Caregiver involvement	-0.014	0.011	-0.251		
Step 2: Professional influences				0.186	0.016
Regression 2: Missed doses					
Step 1: Demographic variables				0.170	0.170
Age of child	0.005	0.004	0.254		
Income	-0.001	0.002	-0.050		
Caregiver involvement	-0.012	0.011	-0.222		
Step 2: Parent influence				0.179	0.009
Regression 3: Missed doses					
Step 1: Demographic variables				0.170	0.170
Age of child	0.004	0.004	0.183		
Income	-0.001	0.002	-0.051		
Caregiver involvement	-0.012	0.010	-0.217		
Step 2: Child				0.303	0.133 <sup>a</sup>
Regression 4: Missed doses					
Step 1: Demographic variables				0.170	0.170
Age of child	0.005	0.004	0.262		
Income	0.000	0.002	-0.035		
Caregiver involvement	-0.012	0.011	-0.226		
Step 2: Fate				0.171	0.001
Regression 5: Late doses					
Step 1: Demographic variables				0.019	0.019
Age of child	0.006	0.005	0.267		
Income	0.001	0.003	0.070		
Caregiver involvement	0.014	0.014	0.204		
Step 2: Professional influences				0.130	0.111

(Continues)

**TABLE 3** (Continued)

Variable	B	SE B	$\beta$	R <sup>2</sup>	$\Delta R^2$
Regression 6: Late doses					
Step 1: Demographic variables				0.019	0.019
Age of child	0.002	0.005	0.095		
Income	0.001	0.003	0.032		
Caregiver involvement	0.009	0.014	0.136		
Step 2: Parent influence				0.115	0.096
Regression 7: Late doses					
Step 1: Demographic variables				0.019	0.019
Age of child	0.002	0.005	0.086		
Income	0.001	0.003	0.075		
Caregiver involvement	0.008	0.014	0.127		
Step 2: Child				0.043	0.024
Regression 8: Late doses					
Step 1: Demographic variables				0.019	0.019
Age of child	0.003	0.005	0.133		
Income	0.001	0.003	0.077		
Caregiver involvement	0.009	0.014	0.135		
Step 2: Fate				0.041	0.021

<sup>a</sup> $P < 0.05$ .

type of involvement may be relevant during adolescence, consistent with prior studies.<sup>12,16,43</sup> Another notable finding was that when more caregivers were involved in the adolescent's medication management, there are more problems with role definition, allocating responsibilities, overseeing health issues, and maintaining positive relationships. It is important to consider that although adult oversight is important for adherence, having fewer individuals involved may lead to improved family functioning, possibly because roles may be more clearly defined and streamlined. Taken together, caregivers may need to balance being emotionally available and supportive with facilitating autonomy in adolescents by helping them develop skills to problem-solve on their own with regard to self-management of their medical condition.

The second aim was to explore the contribution of mothers' beliefs about their child's health in medication non-adherence. Contrary to the original hypothesis, the PHLOC subscales were not significant predictors of non-adherence, with the exception of the Child subscale. That is, when mothers perceived that their adolescents had control over their own health, adolescents missed more doses of medication. This appears to be consistent with prior research that improved adherence is related to parents believing

that either they or medical providers have control over their child's health outcomes, rather than the adolescents themselves.<sup>25,27,29</sup> Within the context of adolescents' developmental stage and the aforementioned results, adolescents may continue to require caregiver intervention to facilitate adherence, although caregivers may have to alter their approach. Specifically, it may no longer be effective to continue to have full control over adolescents' medical regimen. Rather, it is important for caregivers to empower adolescents to engage in tasks that they have control over while providing emotional support and structure to help promote adherence. Direct assistance from caregivers may only be helpful when adolescents experience barriers, such as forgetting, gaps in knowledge, and decreased psychological resources in response to social and academic stressors.<sup>10-12</sup> In this way, caregivers may need to utilize a scaffolding approach with adolescents whereby they explain and demonstrate problem-solving skills first and then allow adolescents more autonomy, only stepping in when adolescents need emotional or physical support.

In addition to these results, this study yielded interesting findings with regard to distinguishing between aspects of medication non-adherence. First, caregiver involvement was negatively

correlated with missed doses, but not late doses. This suggested that when more caregivers are involved, adolescents miss fewer doses. Moreover, the same participants did not necessarily struggle with missing doses and taking doses late. Specifically, 10 adolescents (20%) reported both missed and late doses, two adolescents reported missing doses but otherwise taking doses on time, while 16 adolescents (32%) only endorsed taking doses late. It is likely that adolescents who miss doses may present with different daily barriers (eg, insufficient knowledge of regimen, forgetting, lack of parental involvement, and embarrassment in front of peers) than those who take their medication late (eg, not being home, interfering with activities). These dimensions of non-adherence should be explored separately to understand their unique barriers.<sup>12</sup> This is consistent with prior research, which found differences between adolescents who took their medication late as compared to those who missed it altogether.<sup>44</sup>


Though this study yields important results, there are some limitations. First, although the study sample size is typical for published studies with pediatric illness, it may be too small to detect significant findings due to low power. In addition, the sample consisted primarily of Caucasian, male participants. Thus, it is possible that these findings may be different across other ethnic and gender groups, as previously shown.<sup>45</sup> Moreover, this study utilized only mothers' perceptions of family functioning and PHLOC. Research posits that fathers' perceptions of their children's health behaviors and attitudes can differ<sup>46</sup> and mothers may have more difficulty promoting autonomy in their adolescents than fathers.<sup>47</sup> Thus, future research should explore the role that fathers' perceptions play in predicting adherence. Lastly, even though adherence data were collected using a comprehensive semistructured interview via parent/child report, the study is limited by not including objective measures (ie, drug assays, electronic monitoring) to concur reports. Future studies examining adherence should utilize longitudinal designs, which would allow for collection of objective adherence data over time.

The results of this study demonstrate several potential treatment targets. Findings suggest that it is important to promote effective problem-solving that is more developmentally appropriate and collaborative with adolescents. Moreover, increasing emotional involvement and expression in families may help to increase adherence. As such, adolescents, parents, and medical and psychosocial providers can work together to identify specific aspects of the medical regimen that adolescents have most control over and then facilitate autonomy in those areas, as well as collaboratively plan for parental intervention when necessary to promote adherence among adolescents. It is also crucial to provide parents with support during this stressful time, as they are trying to facilitate autonomy for their adolescents after years of managing their child's medical regimen independently.<sup>47</sup> Lastly, psychosocial interventions directed at improving the parent-child relationship will also be crucial, particularly to improve communication skills and develop appropriate emotion expression and validation.

## AUTHORS' CONTRIBUTIONS

Meghan Marie Kraenbring, Nataliya Zelikovsky, and Kevin E. C. Meyers: Conception and design of study; Meghan Marie Kraenbring: Review of literature; Nataliya Zelikovsky and Kevin E. C. Meyers: Acquisition of data; Meghan Marie Kraenbring and Nataliya Zelikovsky: Analysis and/or interpretation of data; Meghan Marie Kraenbring and Nataliya Zelikovsky: Drafting the manuscript; Meghan Marie Kraenbring, Nataliya Zelikovsky, and Kevin E. C. Meyers: Critically revised the article and approved the final version of the manuscript to be published.

## ORCID

Meghan Marie Kraenbring  <https://orcid.org/0000-0002-1500-1263>

## REFERENCES

- Dew MA, Dabbs AD, Myaskovsky L, et al. Meta-analysis of medical regimen adherence outcomes in pediatric solid organ transplantation. *Transplantation*. 2009;88(5):736-746.
- De Civita M, Regier D, Alamgir AH, Anis AH, Fitzgerald MJ, Marra CA. Evaluating health-related quality-of-life studies in paediatric populations: some conceptual, methodological and developmental considerations and recent applications. *Pharmacoeconomics*. 2005;23:659-685.
- Devine K, Reed-Knight B, Loiselle K, Simons L, Mee L, Blount R. Predictors of long-term health-related quality of life in adolescent solid organ transplant recipients. *J Pediatr Psychol*. 2011;36(8):891-901.
- De Geest S, Dobbels F. Transplantation: increasing adherence to immunosuppression: a clinical priority. *Nat Rev Nephrol*. 2010;6:139-140.
- Ingerski L, Perrazo L, Goebel J, Pai AH. Family strategies for achieving medication adherence in pediatric kidney transplantation. *Nurs Res*. 2011;60(3):190-196.
- Wu Y, Aylward B, Steele R. Associations between internalizing symptoms and trajectories of medication adherence among pediatric renal and liver transplant recipients. *J Pediatr Psychol*. 2010;35(9):1016-1027.
- Dobbels F, Ruppert T, De Geest S, Decorte A, Van Damme-Lombaerts R, Fine RN. Adherence to the immunosuppressive regimen in pediatric kidney transplant recipients: a systematic review. *Pediatr Transplant*. 2010;14:603-613.
- McGrady M, Ryan J, Gutiérrez-Colina A, Fredericks E, Towner E, Pai A. The impact of effective paediatric adherence promotion interventions: systematic review and meta-analysis. *Child Care Health Dev*. 2015;41(6):789-802.
- Lee J, Eaton C, Blount R, et al. The interactive effect of parent personality and medication knowledge on adherence in children awaiting solid organ transplantation. *Health Psychol*. 2017;36(5):445-448.
- DiMatteo MR. Social support and patient adherence to medical treatment: a meta-analysis. *Health Psychol*. 2004;23:207-218.
- Guilfoyle S, Goebel J, Pai A. Efficacy and flexibility impact perceived adherence barriers in pediatric kidney post-transplantation. *Families Systems Health*. 2011;29(1):44-54.
- Zelikovsky N, Schast AP, Palmer J, Meyers KEC. Perceived barriers to adherence among adolescent renal transplant candidates. *Pediatr Transplant*. 2008;12:300-308.



13. Johns Hopkins Medicine. Indications and contraindications for pediatric transplantation. [https://www.hopkinsmedicine.org/transplant/referring\\_physicians/patient\\_selection\\_criteria/kidney\\_pancreas.html#contraindications](https://www.hopkinsmedicine.org/transplant/referring_physicians/patient_selection_criteria/kidney_pancreas.html#contraindications). Accessed March 14, 2018.
14. Herzer M, Godiwala N, Modi A, et al. Family functioning in the context of pediatric chronic conditions. *J Dev Behav Pediatr*. 2010;31(1):26-34.
15. Ylvén R, Björck-Åkesson E, Granlund M. Literature review of positive functioning in families with children with a disability. *J Policy Pract Intellect Disabil*. 2006;3(4):253-270.
16. Al Ghriwati N, Winter M, Everhart R, Fiese B. Family functioning and child asthma severity: a bio-behavioral approach. *Families Systems Health*. 2017;35(4):439-449.
17. Rybak T, Ali J, Diaz-Thomas A, et al. Patterns of family functioning and diabetes-specific conflict in relation to glycemic control and health-related quality of life among youth with type 1 diabetes. *J Pediatr Psychol*. 2017;42(1):40-51.
18. Murphy L, Murray C, Compas B. Topical review: integrating findings on direct observation of family communication in studies comparing pediatric chronic illness and typically developing samples. *J Pediatr Psychol*. 2017;42(1):85-94.
19. Soliday E, Kool E, Lande M. Psychosocial adjustment in children with kidney disease. *J Pediatr Psychol*. 2000;25(2):93-103.
20. Streisand R, Kazak A, Tercyak K. Pediatric-specific parenting stress and family functioning in parents of children treated for cancer. *Children's Health Care*. 2003;32(4):245-256.
21. Shellmer DA, Dabbs AD, Dew MA. Medical adherence in pediatric organ transplantation: what are the next steps? *Curr Opin Organ Transplant*. 2011;16(5):509-514.
22. Killian MO, Schuman DL, Mayersohn GS, Triplett KN. Psychosocial predictors of medication non-adherence in pediatric organ transplantation: a systematic review. *Pediatr Transplant*. 2018;22(4):e13188.
23. Freed R, Tompson M. Predictors of parental locus of control in mothers of pre- and early adolescents. *J Clin Child Adolesc Psychol*. 2011;40(1):100-110.
24. Carbone L, Zebrack B, Plegue M, Joshi S, Shellhaas R. Treatment adherence among adolescents with epilepsy: what really matters? *Epilepsy Behav*. 2013;27(1):59-63.
25. Rosno E, Steele R, Johnston C, Aylward B. Parental locus of control: associations to adherence and outcomes in the treatment of pediatric overweight. *Children's Health Care*. 2008;37(2):126-144.
26. Bilhartz JL, Lopez MJ, Magee JC, Shieck VL, Eder SJ, Fredericks EM. Assessing allocation of responsibility for health management in pediatric liver transplant recipients. *Pediatr Transplant*. 2015;19:538-546.
27. Reichenberg K, Broberg A. Children with asthma. Few adjustment problems are related to high perceived parental capacity and family cohesion. *Nord J Psychiatry*. 2005;59(1):13-17.
28. Barakat L, Lutz M, Nicolaou D, Lash L. Parental locus of control and family functioning in the quality of life of children with sickle cell disease. *J Clin Psychol Med Settings*. 2005;12(4):323-331.
29. Perrin E, Ayoub C, Willett J. In the eyes of the beholder: family and maternal influences on perceptions of adjustment of children with a chronic illness. *J Dev Behav Pediatr*. 1993;14(2):94-105.
30. Epstein N, Baldwin L, Bishop D. The McMaster family assessment device. *J Marital Family Therapy*. 1983;9(2):171-180.
31. Miller I, Epstein N, Bishop D, Keitner G. The McMaster family assessment device: reliability and validity. *J Marital Family Therapy*. 1985;11(4):345-356.
32. Hamilton E, Carr A. Systematic review of self-report family assessment measures. *Fam Process*. 2016;55(1):16-30.
33. Zelikovsky N, Schast AP. Eliciting accurate reports of adherence in a clinical interview: development of the medical adherence measure. *Pediatric Nurs*. 2008;34(2):141-146.
34. Ingerski LM, Baldassano RN, Denson LA, Hommel KA. Barriers to oral medication adherence for adolescents with inflammatory bowel disease. *J Pediatr Psychol*. 2009;35(6):683-691.
35. Rapoff MA. *Adherence to Pediatric Medical Regimens*, 2nd edn. New York, NY: Springer; 2010.
36. Shi L, Liu J, Koleva Y, Fonseca V, Kalsekar A, Pawaskar M. Concordance of adherence measurement using self-reported adherence questionnaires and medication monitoring devices. *Pharmacoeconomics*. 2010;28(12):1097-1107.
37. DeVellis R, DeVellis B, Blanchard L, Klotz M, Luchok K, Voyce C. Development and validation of the parent health locus of control scales. *Health Educ Q*. 1993;20(2):211-225.
38. Lawton K, Kapke T, Gerdes A. Understanding parental locus of control in Latino parents: examination of cultural influences and help-seeking intentions for childhood ADHD. *Cultur Divers Ethnic Minor Psychol*. 2016;22(2):288-298.
39. Gordon EJ, Prohaska T, Gallant M, Sehgal AR, Siminoff LA. Adherence to immunosuppression: a prospective diary study. *Transplant Proc*. 2007;39(10):3081-3085.
40. Miller I, Ryan C, Keitner G, Bishop D, Epstein N. The McMaster approach to families: theory, assessment, treatment and research. *J Family Therapy*. 2000;22(2):168-189.
41. Wallston K, Wallston B, DeVellis R. Development of the multi-dimensional health locus of control (MHLC) scales. *Health Educ Monogr*. 1978;6(2):160-170.
42. Dabbs A, Kim Y, Hamdan-Mansour A, Thibodeau A, McCurry K. Health locus of control after lung transplantation: implications for managing health. *J Clin Psychol Med Settings*. 2006;13(4):381-392.
43. Greenham M, Hearps S, Anderson V, et al. Environmental contributions to social and mental health outcomes following pediatric stroke. *Dev Neuropsychol*. 2015;40(6):348-362.
44. Fredericks EM, Magee JC, Opipari-Arrigan L, Shieck V, Well A, Lopez MJ. Adherence and health-related quality of life in adolescent liver transplant recipients. *Pediatr Transplant*. 2008;12(3):289-299.
45. Tucker C, Petersen S, Vosmik J, et al. Self-regulation predictors of medication adherence among ethnically different pediatric patients with renal transplants. *J Pediatr Psychol*. 2001;26(8):455-464.
46. Gavin L, Wysocki T. Associations of paternal involvement in disease management with maternal and family outcomes in families with children with chronic illness. *J Pediatr Psychol*. 2006;31(5):481-489.
47. Akre C, Suris J. From controlling to letting go: what are the psychosocial needs of parents of adolescents with a chronic illness? *Health Educ Res*. 2014;29(5):764-772.

**How to cite this article:** Kraenbring MM, Zelikovsky N, Meyers KEC. Medication adherence in pediatric renal transplant patients: The role of family functioning and parent health locus of control. *Pediatr Transplant*. 2019;23:e13346. <https://doi.org/10.1111/petr.13346>