

## Adherence of adult Chronic Kidney Disease patients with regard to their dialysis, medication, dietary and fluid restriction

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### Abstract

**Objective:** Chronic Kidney Disease (CKD) has become a major health problem as a result of complicated interrelationships with diabetes mellitus, hypertension and other associated diseases. Effective management of CKD depends on patient's adherence to their dialysis plan, medications, dietary and fluid restrictions. This study aimed at systematically reviewing the adherence of adult Chronic Kidney Disease (CKD) patients with regard to their dialysis, medication, dietary and fluid restriction.

**Methods:** Key words were used for the search in various data bases: “adherence”, “Chronic Kidney Disease”, “dialysis”, “medication”, “dietary” and “fluid restriction”. Online data bases namely Medline, PubMed, Ebsco Host, CINAHL, google scholar and grey literature were used to identify published research from 1993 – 2016. Forty three (43) articles were identified regarding adherence of CKD patients to dialysis, medication, dietary and fluid restriction.

**Results:** Medication non adherence ranged from 3 to 80% through self-report, structured interview and biological markers. Fluid non-adherence was 10-74%. Using self-report and biological markers, non-adherence to diet was 2-39% and 19-57% respectively. With regards to dialysis, skipping and shortening hemodialysis adherence ranged from 2.5% - 19% and 20.3% - 32.3 % respectively. Globally, adherence rates to CAPD are not well documented in literature.

**Conclusion:** Non-adherence to dialysis, medication, dietary and fluid restriction is an area of concern internationally in CKD population. Furthermore, non-adherence rates are not well researched and documented in African literature. Therefore, Nephrology professionals in clinical practice are agents of improving adherence of CKD patients to ensure effective management of the disease.

**Keywords:** Adherence and non-adherence to medication, fluid, diet and dialysis, Chronic Ambulatory Peritoneal Dialysis (CAPD), Chronic Kidney Disease (CKD) and hemodialysis.

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## **Adhésion de patients adultes atteints de maladie rénale chronique en ce qui concerne leur dialyse, leurs médicaments, leur régime alimentaire et leur restriction**

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### **Resume**

**Objectif:** La CKD est devenue une menace majeure pour la santé en raison d'interactions compliquées avec le diabète sucré, l'hypertension et d'autres maladies associées. La prise en charge efficace de l'affection dépend des patients adhérant à leur plan de dialyse, de médicaments, de restrictions alimentaires et fluides, mais il s'agit d'un problème omniprésent. L'étude visait à revoir systématiquement l'adhésion des patients adultes atteints de maladie rénale chronique (CKD) en ce qui concerne leur dialyse, les médicaments, les restrictions alimentaires et de liquide.

**Méthodes:** Les mots clés suivants ont été utilisés pour la recherche: l'observance, la maladie rénale chronique, la dialyse, la médication, la restriction alimentaire et la restriction des fluides. La recherche a identifié 47 articles qui quantifient l'adhésion des patients CKD à la dialyse, à la médication, à la restriction alimentaire et à la restriction des fluides.

**Résultats:** La non-adhésion aux médicaments variait de 3 à 80% grâce à l'auto-évaluation, à l'entrevue structurée et aux marqueurs biologiques. La non-adhésion fluide de 30-74% en utilisant l'auto-rapport et de 10 à 60% sur la base d'un gain de poids interdialytique inapproprié. À l'aide de marqueurs biologiques et d'auto-évaluation, la non-adhésion à l'alimentation était respectivement de 2 à 39% et de 19 à 57%. En ce qui concerne la dialyse, le saut et le raccourcissement de l'hémodialyse ont varié respectivement de 2,5% à 19% et de 20,3% à 32,3%. Globalement, les taux d'adhésion à la CAPD ne sont pas bien documentés dans la littérature.

**Conclusion:** Des preuves documentées ont révélé une non-adhésion à la dialyse, aux médicaments, à la restriction alimentaire et à la restriction des fluides, un domaine de préoccupation international dans la population à CKD. En outre, les taux de non-adhérence ne sont pas bien étudiés et documentés dans la littérature africaine. Par conséquent, les professionnels de néphrologie et / ou de soins intensifs dans la pratique clinique sont des défenseurs d'améliorer l'adhésion des patients de CKD pour assurer la gestion efficace de la maladie.

**Mots-clés:** Adhérence et non-adhérence aux médicaments, aux fluides, à l'alimentation et à la dialyse, à la dialyse péritonéale ambulatoire chronique (CAPD), à la maladie rénale chronique (ERC) et à l'hémodialyse.

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## INTRODUCTION

Chronic Kidney Disease (CKD) affects individuals and health systems in low, middle and high income countries (1) and the global prevalence is estimated at 5 to 10% (2). CKD is also common in Africa although very limited data is collected on prevalence. Moreover, there are no reliable statistics about prevalence of CKD in all African countries due to lack of registries. The available data reveals consistent increase in the incidence of newly diagnosed individuals with CKD with a prevalence of about 10% (3, 4).

CKD is deterioration in kidney function that results in kidney's inability to eliminate waste products, maintain acid base, fluid, and electrolyte balance (5). The disease progression starts with acute kidney injury, which is rapid loss of renal function over hours to a few days, resulting from ischaemic or toxic injury to the kidney causing retention of nitrogenous wastes (6). Untreated acute kidney injury will progress to CKD, an irreversible condition (7) with persistent decrease in estimated Glomerular Filtration Rate (GFR) for at least 3 months (8) and continuous albuminuria which increases gradually from mild to severe levels (9).

According to Kidney Disease International Guidelines Organisation (KDIGO) CKD Work Group (9), the progression is from normal glomerular filtration rate (GFR) of  $>90\text{ml/min/1.73m}^2$  (stage 1) to mild impairment (GFR  $60\text{--}90\text{ml/min/1.73m}^2$ ) (stage 2), then moderate impairment (GFR  $30\text{--}59\text{ml/min/1.73m}^2$ ) (stage 3) leading to severe impairment (GFR  $15\text{--}29\text{ml/min/1.73m}^2$ ) (stage 4). Ultimately, it leads to CKD stage 5 (Morton & Fontaine, 2009) which is complete failure of the kidneys to function at a level that is necessary for day-to-day life and kidney function less than 15% of normal GFR (9).

Integrated management of CKD puts emphasis on dialysis, medication, and dietary and fluid restriction. Individuals with CKD have comorbid conditions namely diabetes mellitus and hypertension which contributes to more than 36% and 24% of cases of ESRD respectively (4) as well as an increased risk of developing complications that affect all systems of the body. Other causes of CKD includes glomerulonephritis, interstitial nephritis, congenital malformations, genetic disorders and obstructive uropathy (4). Therefore, medication is needed to manage comorbid and other conditions associated with CKD conditions as this slows the progression of CKD to end-of-life

stages (10).

Similarly, nutritional therapy in CKD minimises uremic and anaemia symptoms, reduce the incidence of fluid, electrolyte and acid base imbalances, reduce patient's vulnerability to infections and limit catabolism (11). Moreover, removal and control of excess fluid is the cornerstone of volume management in CKD patients (12) as this prevent fluid overload. More importantly, Renal Replacement Therapy (RRT) is essential for management of advanced CKD and encompasses Chronic Ambulatory Peritoneal Dialysis (CAPD), haemodialysis and renal transplant (13). Chronic peritoneal dialysis and haemodialysis are dialytic therapies which remove toxins; solutes and fluid from blood through three principal mechanisms namely osmosis, diffusion and filtration (14).

In this regard, patients' adherence to dialytic procedures, medications, dietary and fluid restrictions is paramount in proper management of CKD population. Yet, low adherence to dialysis, medication, diet and fluid control is evident in more than half of the patients treated for CKD (15). Furthermore, patients with CKD need to cope with dependence in performing activities of daily living such as detrimental physical symptoms, limitations in dietary and fluid intake, changes in body image, work and a crippled economic status (16). The end result of these challenges is a cause of changed normal routines hence prediction of their control over treatment is difficult (18). Although the available literature still indicates problems of adherence among CKD population, little or no summative reviews that document and quantify adherence in four modalities namely dialysis, medication, fluid and dietary restriction exist. . Therefore, this systematic literature review aims to document and quantify the level of adherence to dialysis, fluid, diet and medication from the results of previous studies and to identify instruments and methods of measuring adherence among CKD adult population.

## MATERIALS AND METHODS

A conclusive literature search was conducted to identify studies that quantify adult CKD patient's adherence to medication, diet, fluid intake and dialysis. The following data bases were used to find the research articles: Medline, PubMed, Ebsco Host, CINAHL, google scholar and grey literature. The key words used for the search were: adherence, Chronic Kidney Disease, dialysis, medication, dietary and fluid

restriction. The inclusion criteria included all research articles from 1993 to 2016. Included also in the review were quantitative articles written in English that accurately indicate and quantify the rate of adherence to medication, diet, fluid intake and dialysis among adult CKD population. Excluded in the review were qualitative articles, articles with pediatric adherence (<18), intervention studies and case studies. Duplicates were also excluded after critical review by two independent reviewers. Figure 1 shows a flow chart of the search strategy for identified articles.

## RESULTS

Overall, there were forty three (43) articles identified from the comprehensive search on CKD adherence. Operational definition of adherence was highlighted. Instruments and methods of measuring adherence in CKD population were also revealed. Moreover, studies that quantify adherence rates to dialysis, medication, fluid and diet control were identified. Of the forty three articles, seven (7) were identified for dialysis adherence, nine (9) were for medication adherence, 14 articles were for fluid adherence and 13 articles were for dietary adherence. The results of the review are presented as follows:

### Adherence

Cramer et al (17) defined adherence as following the recommendations made by the provider with respect to timing, dosage, and frequency of medication taking where the patient follows the prescribed interval and dose. The same author highlighted adherence as a measure implemented over a period of time in percentage form. Sabate (18) echoed the same sentiments and included person's behavior in taking medication, following a diet and making changes in lifestyle according with health professional recommendations. In this review, adherence was conceptualised as CKD patients' ability and behaviour to follow a dialysis plan, medication, diet and fluid restriction with respect to right timing, right dosage at prescribed intervals.

### Methods for measuring adherence in CKD patients

The methods of measuring adherence to dialysis, medication, fluid and dietary restriction in CKD patients were identified. The identified methods of assessing adherence in CKD patients were: self-report, biological markers and

Intradialytic Weight Gain (IDWG) (Table 1)

### Instruments used in measuring adherence for CKD patients

The instruments used in measuring adherence among CKD patients that have been developed and tested for use. The identified instruments include dialysis, diet and fluid non-adherence questionnaire (DDFQ) (19) and End Stage Renal Disease Adherence Questionnaire (ESRD: AQ) (20) which measures treatment adherence behaviors in four dimensions namely dialysis attendance, medication use, fluid restriction and diet recommendation (Table 2).

### Dialysis adherence

Table 3 displays seven (7) studies identified for dialysis adherence. Sample size ranged from 40 in Turkey to 6251 in USA. The percentage of patients who are non-adherent through skipping varies from 2.5% in Turkey to 19% in USA (21, 22, 23, 24, 25, and 26) and through shortening from 20.3% to 32% in USA (22, 23). In a study from Africa, Zimbabwe showed non-adherence rate of 97.6% which was very high (27). On the contrary, non-adherence is virtually nonexistent in Japan and Sweden (25).

### Medication adherence

Nine (9) studies revealed for medication adherence are shown in Table 4. Sample sizes ranged from 30 to 5478 and rates of medication non-adherence were measured using self-report. Non adherence to phosphate binders, antihypertensive, calcium supplements and vitamins ranged from 3% to 80%, antihypertensive and phosphate binders from 21% to 73% and phosphate binders alone ranged from 17.4% to 24% (28, 29, 30, 31, 32, 33, 34, and 35). Still, there are no documented adherence rates to medication in literature for African region

### Fluid adherence

Table 5 shows fourteen (14) studies identified for fluid adherence of adult CKD patients and their non-adherence rates. The sample size ranged from 21 in the United Kingdom to 6251 in the USA. Self-report and intradialytic weight gain were used to measure fluid adherence in CKD participants. Non adherence using inter-dialytic weight gain ranged from 9.7% in USA to 70% in UK (24, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44). Through self-report, non-adherence to fluid intake ranged from 40.3% in China to 72% in Belgium (19, 45). Studies and

documentation on adherence rates to fluid intake in African region were limited

### **Dietary adherence**

There are thirteen studies selected for adult dietary adherence as shown in Table 6. Sample size ranged from 62 in Hong Kong to 6251 in USA. In the case of potassium and phosphorus intake, dietary non-adherence is estimated at 2% in USA to nearly 39% in Hong Kong (18, 22, 24, 32, 35, 42). Self-reported estimates of potassium and phosphorus intake ranged from 44% in Hong Kong to 81% in Belgium (19, 32, 46, 47). Protein non-adherence ranged from 4.5% in Iran to 77% in USA. In South Africa, self-reported non adherence to renal diet was 84% (36). Still, few documented published research studies on adherence rates in the African continent were found.

## **DISCUSSION**

### **Methods of measuring adherence**

Direct questioning and self-report instruments are most effective measures (19) if they are validated. The disadvantage of self-report is bias as patients usually underestimate their non-adherence rates (48). Biochemical markers are also important in measuring adherence in CKD patients. However, they are influenced by many other variables such as residual urine volume, dialysis sessions and body weight. Nonetheless, the continual lack of accepted value for each biochemical marker gives doubt to reliability of the tools that assesses rates adherence in CKD population (35). For instance, potassium and phosphate values reflect residual renal function, dialysis adequacy and adherence with medication (35, 49) in addition to food intake (50, 51).

Studies have shown that Intradialytic Weight Gain (IDWG) is a valid and objective measure of fluid restriction assessment in patients with CKD (24, 49, 52,) thus being widely used as an outcome measure (50, 52) in assessment of fluid restriction. Mean IDWG expressed as percent dry weight is one of the methods to measure fluid adherence (38). However, it is seen as an unfit measure since dry weight can only be estimated. Nevertheless, the researchers continue to agree that IDWG should be defined as a percentage of dry weight (38, 53). Furthermore, the point which defines fluid adherence is different in literature (54). However, research based practice states that IDWG should be less than 2.5 kg or 3.5% of dry body weight so

as to reduce the excess fluid during dialysis sessions (53).

The disadvantage of biological markers is that they are influenced by many other variables such as residual urine volume, duration of dialysis session, the length of the intervals between 2 sessions and body weight. Nonetheless, lack of universally accepted cut off value for each marker raises the question of whether these measures are reliable tools to assess non adherence rates in CKD population (35). Potassium and phosphate values reflect not only food intake (49, 50) but residual renal function, dialysis adequate, time at which blood was taken for analysis between dialysis, acid base and hormonal status and adherence with medication (32, 35)

### **Instruments for measuring adherence**

There are differences in non-adherence rates due to lack of reliable instruments. Nevertheless, literature reveals two adherence scales that have been tested for use in patients with CKD. The dialysis, diet and fluid adherence instrument measures adherence to dialysis, fluid intake and dietary restrictions for the past two weeks (19). However, the weakness of DDFQ lies in not addressing medication use among CKD patients. Therefore measurement of adherence was limited. In view of this, Kim et al (20), developed an End Stage Renal Disease Adherence Questionnaire (ESRD: AQ) which measures adherence behaviors in four modalities namely; dialysis, medication, fluid restriction and dietary intake. Therefore, this instrument maybe used to measure adherence in all the four dimensions which encompasses the comprehensive care of patients with CKD.

### **Adherence to medication, fluid, dialysis and diet in CKD patients**

Different rates of adherence are reported globally (Table 7). The non-adherence rates to dialytic procedures, medication, fluid and dietary changes ranges from 0-53%, 1.2-81%, 3.4-74% and 1.2-82.4% respectively (21, 24, 28, 32, 35, 36, 37,38). This support documented evidence of poor adherence in all key aspects of integrated management among CKD patients. Dialysis has transformed the prognosis of patients with kidney disease but its effectiveness is unfortunately compromised by non-adherence (18). Because of the demands of haemodialysis, many patients do not adhere to the prescribed regimen there by jeopardising successful clinical outcomes.

Inadequate adherence is common in CKD patients undergoing chronic haemodialysis and as many as 86% of the patients in the United Kingdom may be considered non-adherent to the treatment (17).

The availability of data that reveals adherence rates to haemodialysis of renal failure patients is lacking in all African countries. The study done by Chironda et al (27) showed non-adherence to haemodialysis of 97.6%. This high rate of non-adherence in African countries is exacerbated by low socioeconomic status as most patients have no access to haemodialysis procedures and health insurance making care for CKD unaffordable (36). World Kidney Day (2012) echoed the same sentiments of CKD patients discontinuing dialysis due to limited economic resources in developing nations

Similarly, non-adherence to Peritoneal Dialysis (PD) dialysis procedure is scarce in literature although the dialytic procedure is available in all continents. Dean and Cruz (55) expressed the same sentiments and explained peritoneal dialysis as an inexpensive procedure which requires less infrastructure. Again, peritoneal dialysis is a convenient procedure which a patient can implement in their own homes. However, Lim et al (56) highlighted diminished and impairment of quality of life among patients on peritoneal dialysis. Griva et al (21) reveals the rates of non-adherence to Continuous Ambulatory Peritoneal Dialysis (CAPD) procedures ranged from 2.6–53%. The same author highlighted that missed PD exchanges were reported to be in a range of 2.5–53%, shortening by 4–15% of patients and performing less than 90% of prescribed exchanges was evident in 2–40% of patients. Indirect biochemical/ physiological measures reveals adherence rates at 74–78%.

Medication non-adherence remains a major obstacle among patients with CKD. Individuals with CKD have comorbid conditions as well as an increased risk of developing complications that affect all systems of the body, are more likely to die from these complications than CKD. Diuretics, antihypertensive and anti-diabetics are of importance and these drugs have proved to slow progression of CKD (11). Moreover, medications to manage pulmonary, gastrointestinal, neuromuscular, haematological, skeletal, integumentary and dietary intake alterations are needed (11). These medications can only work effectively if CKD patients are fully adherent with their treatment.

Prevention of fluid overload is the basis for fluid management in patients with CKD. Available literature indicates a daily fluid allowance of 0.5 litres in addition to the volume equal to daily urine output (12). Dietary sodium intake and medication containing sodium increase fluid overload (52) in patients with CKD. However, adequate dialysis removes excess fluid (57) in CKD patients. Therefore, effective fluid management in CKD population centres on dialysis, medication and dietary adherence.

Chronic Kidney failure needs dietary management in energy intake and nutrients to decrease morbidity and mortality (58). CKD patients should avoid high sodium and potassium diet to manage hypertension thereby decreasing the incidence of stroke. Furthermore, diet low in saturated fats is advised as evidence highlight this group of patients as high risk for development of coronary artery disease due to elevated levels of serum triglycerides and low high density lipoproteins (59).

## CONCLUSION

Low adherence is of concern in CKD patients as previous studies reveal a greater number of patients deviating from dialysis, medication, fluid and dietary restrictions. There is need for more research and documentation of adherence rates among CKD patients especially in African countries. Controlling and managing the detrimental effects of CKD is the main focus. Therefore, the nephrology team which includes nephrologist, nurses, dieticians, social workers, dialysis technicians and pharmacists should implement a multidisciplinary approach in engaging CKD patients with their management. This will promote positive adherent behaviors and consequently effective management of the CKD population.

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Table 1: Methods of measuring adherence in Chronic Kidney Disease (CKD) patients

<b>Management modality</b>	<b>Method of measuring adherence</b>
Medication	❖ Self-report ❖ Biological markers
Diet	❖ Self-report ❖ Biological markers
Fluid	❖ Self-report ❖ Intradialytic weight gain (IDWG)
Dialysis	❖ Self-report missed dialysis ❖ Self-report shortened dialysis ❖ Biological markers

Table 2: Instruments for measuring adherence in Chronic Kidney Disease (CKD) patients

<b>Name of instrument</b>	<b>Management modality</b>
The Dialysis, Diet and Fluid non-adherence Questionnaire (DDFQ) (2001)	Dialysis, Diet and fluid
End Stage Renal Disease Adherence Questionnaire (ESRD: AQ)(2010)	Diet, medication, fluid and dialysis

Table 3: Studies identified for dialysis adherence in Chronic Kidney Disease (CKD) patients

Author, year	Sample	Measurement	Non adherence	Adherence	Country
Sherman, 1994	860	Skipped Shortened	5.1 – 7.9% 26.8 – 32.3%	92.1 –94.9% 67.7 –73.2%	USA
Leggat et al, 1998	6251	Skipped Shortened	8.5% 20.3%	91.5% 79.7%	USA
Bleyer et al, 1999	Japan 194 Sweden 84	Skipped	Japan- 0 Sweden- 0	Japan- 0 Sweden- 0	Japan Sweden
Kutner et al, 2002	119	Skipped Shortened	19% 31%	81% 69%	USA
Hecking et al, 2004	France 672 Germany 571 Italy 600 Spain 576 UK 620	Skipped Shortened	France -0.3% Germany-0.9% Italy- 8.8% Spain- 6.6% UK – 12.6%	France-99.7% Germany99.1% Italy- 91.2% Spain- 93.4% UK – 87.4%	France Germany Italy Spain UK
Chironda et al, 2014	80	Skipped and missed	97%	3%	Africa
Griva et al, 2014		Missed Shortened Self-report Biological	2.5 – 53% 4– 15% 2 – 40% 22 – 26%	47 – 97.5% 85 – 96% 60 – 98% 74 – 78%	Singapore

Table 4: Studies identified for medication adherence in Chronic Kidney Disease (CKD) patients

<b>Author, year</b>	<b>Sample</b>	<b>Medication</b>	<b>Non adherence</b>	<b>Adherence</b>	<b>Measurement</b>
<b>Bame et al, 1993</b>	1230	PB, AHT, CAS	50%	50%	Phosphorus > 6.0 mg/dl
<b>Kaplan et al, 1994</b>	30	PB, AHT	67%	33%	Self-report
<b>Cleary et al, 1995</b>	51	AHT, PB, CAS, VITS	61%	39%	Phosphorus > 5.5 mg/dl & self-report
<b>Lin &amp; Liang, 1997</b>	86	PB CAS	24% 61%	76% 39%	Phosphorus > 4.59mg/dl & self-report
<b>Curtin et al, 1999</b>	135	AHT & PB	73%	27%	Mems & self-report
<b>Tornasello, 2004</b>	129	PB	23%	77%	Phosphorus > 5.5 mg/dl and self-report
<b>Holley &amp; Devore, 2006</b>	39	AHT, PB	21%	79%	Self-report
<b>Hirth, 2008</b>	5478	AHT, PB, CAS	3-29%	71-97%	Self-report
<b>Magacho, et al, 2011</b>	149	PB	17.4%	82.6%	Self-report

PB- Phosphate binders, AHT – Antihypertensive, CAS – Calcium supplements, VITS – Vitamin

Table 5: Studies identified for fluid adherence in Chronic Kidney Disease (CKD) population

<b>Author, year</b>	<b>Sample</b>	<b>Measurement</b>	<b>Non adherence</b>	<b>Adherence</b>	<b>Country</b>
Bame et al, 1993	1230	IDWG	49.5%	51.5%	USA
Leggat et al, 1998	6251	IDWG	9.7%	90.3%	USA
Christensen, 1995	57	IDWG	42%	58%	USA
Casey et al, 2002	21	IDWG	60%	40%	UK
Vlamnick et al, 2001	564	SR	72%	28%	Belgium
Durose, et al 2004	82	IDWG	23%	77%	UK
Barnet et al, 2007	26	IDWG	53%	47%	Australia
Kara et al, 2007	160	SR	68.1%	31.9%	Turkey
Russel et al, 2007	107	IDWG	40%	60%	USA
O Connor et al, 2008	73	IDWG	70%	30%	UK
Lindberg et al, 2009	4498	IDWG	30%	70%	Sweden
Chan et al, 2012	Not stated	IDWG	24.5%	75.5%	Malaysia
Khalil, & Darawad, 2014	90	IDWG SR	17%- 80%	20% - 83%	Jordan
Chironda & Bhengu, 2016	90	IDWG SR	89%	11%	South Africa

IDWG – Intradialytic weight gain, SR – Self report

Table 6: Studies identified for Dietary adherence in Chronic Kidney Disease (CKD) patients

Author, year	Sample	Measurement	Non adherence	Adherence	Country
<b>Bame et al, 1993</b>	1230	Potassium Phosphorus	2% 50%	98% 50%	USA
<b>Leggat et al, 1998</b>	6 251	Phosphorus	22.1%	77.9%	USA
<b>Vlamnick et al, 2001</b>	564	Self-report	81.4%	18.6%	Belgium
<b>Durose et al, 2004</b>	82	Potassium Phosphorus	4% 31%	96% 69%	United kingdom
<b>Hecking et al, 2004</b>	3039	Potassium Phosphorus	11.7% 23.8%	88.3% 76.2%	France, Germany, Italy and Spain
<b>Kugler et al, 2005</b>	916	Self-report	81.4%	18.6%	Germany and Belgium
<b>Unruh, et al, 2005</b>	739	Phosphate Potassium	33.3% 2%	66.7%	USA
<b>Kara et al, 2007</b>	160	Self-report	58.1%	41.9%	Turkey
<b>Russel et al, 2007</b>	107	Phosphate Albumin	68% 77%	32% 23%	USA
<b>Rambod, 2010</b>	Not stated	Phosphate Potassium Protein	25.5% 5.5% 4.5%	74.5% 94.5% 95.5%	Iran
<b>Lee and Mollasiotis, 2002</b>	62	Potassium Phosphate Self-report	38.7% 56.5% 44%	61.3% 43.6% 56%	Hong Kong
<b>Khalil, &amp; Darawad, 2014</b>	90	Self- reportpotassiu m, phosphorus blood urea nitrogen	17% - 80%	20% - 83%	Jordan
<b>Chironda &amp; Bhengu, 2016</b>	90	Self-report	84%	16%	South Africa

**Table 7- Overall adherence rates to medication, diet, fluid and dialysis for Chronic Kidney Disease (CKD) patients**

<b>Management Modality</b>	<b>Non adherence rate</b>	<b>Adherence rate</b>
Medication	3-80% through self-report and biological markers	20 – 97% through self-report and biological markers
Fluid	30-80% - self report 10-60%- interdialytic weight gain (IDWG)	26 - 70% - self report 40 - 90%- interdialytic weight gain (IDWG)
Diet	2-39% - self report 19-57%- biological markers	61 - 98% - self report 19-57% - biological markers
Hemodialysis	0-35%-skipping hemodialysis 2-32%-shortened hemodialysis	65-100%-skipping hemodialysis 68-98%-shortened hemodialysis
Continuous ambulatory peritoneal dialysis (CAPD)	2.5 – 53% - Missed PD exchanges 4 – 15% - Shortening PD exchanges 22- 26 % - Biological markers	47 – 97.5% - Missed PD exchanges 85 - 96% - Shortening PD exchanges 74 - 78 % - Biological markers

**Figure 1- Flow Chart of Search Strategy and Results**

