

# Forecast of the incidence, prevalence and burden of end-stage renal disease in Nanjing, China to the Year 2025

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## Background

There are limited data on the trends of incidence or prevalence of end stage renal disease (ESRD) in China. To assist in future planning for the ESRD program, the trends of incidence, prevalence and health care costs were analyzed and forecasted to the year 2025 by modeling of historical data from 2004 through 2014.

## Methods

Nanjing urban employee basic medical insurance (NJUEBMI) data were obtained from the Nanjing Medical Insurance Information System from 2004 to 2014. The time series forecasting system in SAS 9.4 was used. Each variable was independently forecasted by the fittest model, which was selected automatically or manually.

## Results

The forecasting models demonstrated mean percent errors of -2.49% to 5.62%, relative to the observed values. The R-square values for the forecasting models ranged from 0.756 to 0.997. On the basis of trends in the historical data, the models projected that the average annual increase in the NJUEBMI population was 4.77%, with forecasted values of 5,029,270 in 2025 (95% CI, 4,960,423-5,098,117). The incidence and prevalence of ESRD were projected to increase by 1.19% and 1.95% annually and were expected to reach 250.5 pmp(95% CI, 247.7-253.3) and 1505 pmp(95% CI, 1450-1560) by 2025. Additionally, the costs associated with ESRD were forecasted to increase at a growth rate of 5.80% for healthcare costs and 7.25% for per capita medical expenses, with forecasted values of ¥600.3 million (\$92.4 million) (95% CI, 541.8-658.9) and ¥99.0 thousand (\$15.2 thousand) (95% CI, 98.6-99.3), respectively, by 2025. The incidence and prevalence of kidney transplantation were projected to decrease by 6.58% and 9.79% annually.

## Tables and Figure

Table 1. Observed and forecasted values for selected years<sup>a</sup>

	2009	2014	2015	2020	2025	APC Period 2004-2014
Number of NJUEBMI population (No.)	2,032,074	2,068,097	3,199,022	4,062,948	5,029,270	4.77%
(Linear Trend) <sup>b</sup>	2,050,731	2,921,095	(3,087,175-3,224,895)	(4,023,796-4,161,493)	(4,960,423-5,098,117)	
Incidence (pmp)						
All ESRD	205.9	219.8	222.8	226.5	250.5	1.19%
(Linear Trend)	206.8	218.8	(219.8-225.4)	(233.7-239.4)	(247.7-253.3)	
HD	171.5	183.5	185.9	197.9	209.9	1.22%
(Linear Trend)	171.2	182.5	(184.2-187.6)	(196.2-199.6)	(208.2-211.7)	
PD	22.9	27.9	28.9	34.3	39.8	3.25%
(Damped Trend Exponential Smoothing)	22.4	27.4	(26.9-30.9)	(32.0-36.6)	(37.2-42.3)	
Kidney Transplant	12.4	8.8	8.1	5.8	4.1	-6.58%
(Log Linear (Hot) Exponential Smoothing)	13.2	8.9	(7.0-9.4)	(4.9-6.7)	(3.4-5.0)	
Prevalence (pmp)						
All ESRD	1083	1215	1241	1373	1505	1.95%
(Linear Trend)	1083	1228	(1186-1297)	(1318-1428)	(1400-1500)	
HD	815.9	928.8	967.4	1070	1126	1.55%
(Damped Trend Exponential Smoothing)	820.2	942.5	(915.4-1019)	(965.5-1074)	(1029.1-1127)	
PD	74.0	120.8	120.9	176.8	223.2	5.56%
(Linear Trend)	71.7	126.3	(124.5-135.4)	(171.1-182.0)	(217.7-228.7)	
Kidney Transplant	166.7	150.3	141.2	95.8	50.4	-9.79%
(Linear Trend)	160.7	160.8	(128.6-153.8)	(83.2-108.4)	(37.8-63.0)	
Health care costs (K, in millions)						
All ESRD	172.0	318.9	341.5	470.9	600.3	5.80%
(Linear (Hot) Exponential Smoothing)	168.5	315.6	(323.9-359.0)	(427.7-514.1)	(541.8-658.9)	
HD	100.5	271.7	294.0	405.3	516.5	5.80%
(Linear Trend)	103.5	275.5	(279.3-308.7)	(360.6-419.9)	(501.9-531.2)	
PD	7.8	32.2	34.1	45.9	54.8	4.82%
(Damped Trend Exponential Smoothing)	10.5	31.1	(30.1-38.1)	(18.3-23.5)	(-4.0-11.2)	
Kidney Transplant	5.3	9.0	9.8	13.5	17.3	5.85%
(Logistic Linear Trend)	4.5	9.0	(8.0-10.9)	(12.4-14.7)	(16.1-18.4)	
Per capita medical expenses (K, in thousands)						
All ESRD	96.1	90.3	92.1	97.1	99.0	7.25%
(Logistic Linear Trend)	79.9	87.9	(89.2-94.2)	(96.0-97.9)	(98.6-99.3)	
HD	88.7	104.7	106.5	120.8	136.0	2.40%
(Linear (Hot) Exponential Smoothing)	91.2	100.1	(98.8-114.3)	(112.2-126.4)	(126.7-144.4)	
PD	68.2	92.3	94.4	98.9	99.8	5.58%
(Logistic Linear Trend)	71.3	84.9	(84.9-98.1)	(96.9-99.6)	(99.4-99.9)	
Kidney Transplant	12.7	20.5	22.1	26.9	37.8	5.51%
(Linear Trend)	11.8	19.2	(19.8-24.5)	(27.5-32.4)	(35.3-40.2)	

Abbreviations: APC, annual percentage change; NJUEBMI, Nanjing urban employee basic medical insurance; ESRD, end stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; pmp, per million population.

<sup>a</sup> The top values for each variable are the forecasted values. The bottom values for each variable in the 2009 and 2014 columns are the observed values. The bottom values in the 2015, 2020, and 2025 columns are 95% confidence intervals for the forecasts.

<sup>b</sup> The selected forecasting models are listed in the brackets below each variable, separately.

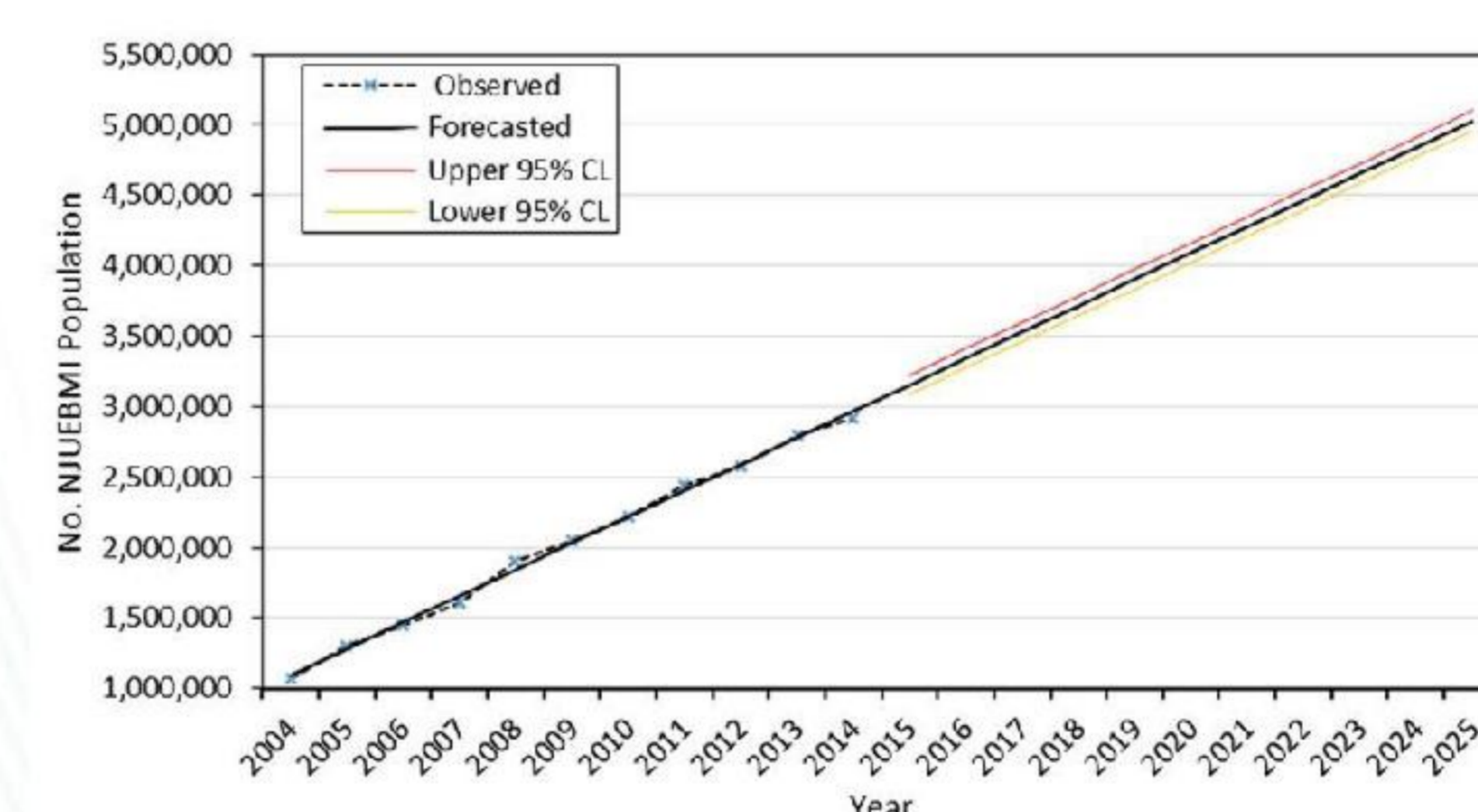


Figure 1. Forecasted NJUEBMI population counts according to the linear trend model.

The asterisk and dashed line represent the observed data, the solid line indicates the forecasted counts, and the lines above and below the solid line from 2015 to 2025 indicate the upper and lower 95% confidence limits (CI), respectively, for the forecasted counts.

Table 2. Goodness-of-fit statistical values

	Mean error <sup>a</sup>	Maximum error	Minimum error	Mean percent error <sup>b</sup>	Maximum Percent Error	Minimum Percent Error	R-Square <sup>c</sup>
Number of NJUEBMI population (No.)	2.27E-05	55591	-47833	-0.09	2.93	-2.88	0.997
Incidence (pmp)							
All ESRD	3.23E-09	1.57	-1.55	-3.07E-03	0.73	-0.75	0.943
HD	-3.28E-09	0.94	-0.98	-1.73E-03	0.53	-0.54	0.971
PD	0.15	1.52	-0.85	0.56	5.86	-2.78	0.889
Kidney Transplant	-0.12	0.83	-1.04	-1.42	6.29	-10.88	0.756
Prevalence (pmp)							
All ESRD	4.55E-09	58.32	-43.33	-0.07	5.36	-4.77	0.915
HD	1.17	24.73	-65.08	0.12	2.78	-8.16	0.931
PD	-2.73E-10	4.7	-4.92	0.41	10.93	-5.61	0.903
Kidney Transplant	-3.09E-09	10.31	-9.57	-0.06	6.42	-4.9	0.961
Health care costs (K, in millions)							
All ESRD	-0.94	16.91	-15.22	-1.57	7.09	-13.46	0.990
HD	-1.55E-09	8.89	-12.8	0.83	15.31	-12.41	0.991
PD	0.49	3.83	-1.61	5.82	37.36	-9.99	0.969
Kidney Transplant	-1.00E-10	0.95	-0.88	-0.36	29	-23.87	0.953
Per capita medical expenses (K, in thousands)							
All ESRD	-2.11	3.35	-2.99	-2.27	3.88	-4.48	0.942
HD	0.48	4.79	-4.8	0.45	5.34	-5.38	0.777
PD	-0.94	8.46	-8.89	-2.49	9.46	-13.08	0.852
Kidney Transplant	-2.50E-11	1.94	-1.34	-0.7	10.93	-12.1	0.917

Abbreviations: NJUEBMI, Nanjing urban employee basic medical insurance; ESRD, End stage renal disease; HD, hemodialysis; PD, peritoneal dialysis; pmp, per million population.

<sup>a</sup> The mean error indicates an average difference (2004 to 2014) of the forecasted values from the observed values. The maximum error indicates one of the 11 years (2004 to 2014) that exhibited the largest deviation of the forecasted value from the observed value, and the minimum error indicates the smallest deviation. A positive sign indicates over forecasting, whereas a negative sign indicates under forecasting.

<sup>b</sup> The mean percent error reflects a proportional deviation of the mean error. Maximum and Minimum percent errors reflect proportional deviations of the largest and smallest errors, respectively.

<sup>c</sup> The R-Square indicates the correlation between the observed values and the forecasted values.

Table S1. The data on the development of the population, economy and social insurance in Nanjing City (2004-2014)<sup>\*</sup>

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Resident Population (10,000)	668.18	689.8	719.06	741.3	758.89	771.31	800.76	812.00	816.10	818.78	821.61
UEBMI Population	1075013	1301882	1447189	1611073	1900340	2050731	2225205	2441197	2577000	2802096	2921065
(%) <sup>**</sup>	(16.1)	(18.9)	(20.1)	(21.7)	(25.0)	(26.6)	(27.8)	(30.1)	(31.6)	(34.2)	(35.6)
Per capita disposable income of urban residents (CNY)	11602	14897	17538	20517	23123	25504	28932	32200	36322	39881	42568
(Growth ratio %)	(13.8)	(19.9)	(16.9)	(15.9)	(13.8)	(13.3)	(11.0)	(13.7)	(12.8)	(9.8)	(8.8)
Per capita disposable income of rural residents (CNY)	5531	6225	7045	8020	8951	9858	11138	13108	14786	16531	17861
(Growth ratio %)	(12.4)	(12.5)	(13.2)	(13.8)	(11.6)	(10.1)	(12.9)	(17.8)	(12.8)	(11.8)	(10.1)
Basic medical insurance coverage (%)	NA	NA	NA	NA	NA	>98.0	>98.0	>98.0	98.7	98.1	>98.0
Total GDP (Billion CNY)	1910	2413	2773.7	3283.7	3814.6	4230.2	5012.6	6145.5	7201.5	8011.7	8820.4
(Growth ratio %)	(17.3)	(15.2)	(15.1)	(15.7)	(12.1)	(11.5)	(13.1)	(12.0)	(11.7)	(11.0)	(10.1)

Abbreviations: UEBMI, Urban employee basic medical insurance; CNY, Chinese Yuan; NA, not available.

<sup>\*</sup>All the data were obtained from the annual report on the development of the Nanjing population by Nanjing Population and Family Planning Commission, and the annual report on the Nanjing economic and social development by Nanjing Municipal Bureau of Statistics.

<sup>\*\*</sup>Numbers in the brackets were presented as the percentage of the resident population.

## Conclusion

These projections suggest that the incidence, prevalence, healthcare costs, and per capita medical expenses of ESRD would increase in the NJUEBMI population. They provide a basis for discussing the trends of ESRD in China and facing the challenges from the ESRD program.