

# Association between Dietary Iron Levels and All-Cause and Cancer-Cause Mortality: A Prospective Cohort Study

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**Table 1:** Baseline characteristics of included population.

Variables	Total	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018	P value
Iron_mg	15.22(0.07)	15.26(0.32)	15.58(0.28)	15.89(0.20)	16.24(0.18)	15.39(0.30)	15.36(0.19)	15.68(0.19)	14.57(0.11)	14.12(0.21)	14.21(0.19)	< 0.0001
Age	47.41(0.19)	45.77(0.52)	45.95(0.48)	47.20(0.53)	47.16(0.78)	47.20(0.42)	47.93(0.52)	48.25(0.79)	48.21(0.40)	48.58(0.61)	47.20(0.79)	0.001
Sex												0.93
Male	19370(49.27)	1434(48.40)	1917(49.98)	1866(49.19)	1906(49.39)	2244(48.71)	2308(49.39)	2023(49.96)	2113(49.54)	2051(49.06)	1508(48.82)	
Female	19136(50.73)	1420(51.60)	1812(50.02)	1800(50.81)	1768(50.61)	2244(51.29)	2309(50.61)	1917(50.04)	2191(50.46)	2094(50.94)	1581(51.18)	
Race												0.57
Non-Hispanic White	18108(70.94)	1352(72.98)	2015(73.88)	2005(73.81)	1912(73.90)	2214(71.77)	2375(71.41)	1604(70.05)	1989(68.84)	1503(67.66)	1139(65.91)	
Mexican American	6456( 7.48)	729(5.65)	772(6.78)	714(7.23)	686(7.28)	740(7.88)	799(7.89)	357(6.71)	545(8.42)	718(8.22)	396(8.19)	
Other Race - Including Multi-Racial	3119( 6.11)	86(4.17)	107(3.87)	135(4.80)	136(5.01)	158(5.14)	214(5.67)	585(6.96)	557(7.20)	545(7.99)	596(9.67)	
Non-Hispanic Black	7849(10.34)	505( 9.04)	689( 9.98)	707(10.65)	833(10.64)	914(10.80)	804(10.58)	1018(10.47)	844(10.35)	844(10.33)	691(10.22)	

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Other Hispanic	2974( 5.13)	182(8.15)	146(5.49)	105(3.52)	107(3.18)	462(4.42)	425(4.45)	376(5.82)	369(5.19)	535(5.80)	267(6.02)	
<b>Cancer</b>												< 0.0001
No	34752(90.20)	2605(92.55)	3377(91.25)	3298(90.87)	3354(91.76)	4031(90.80)	4120(89.25)	3592(90.35)	3865(88.18)	3710(87.88)	2800(90.06)	
Yes	3754( 9.80)	249( 7.45)	352( 8.75)	368( 9.13)	320( 8.24)	457( 9.20)	497(10.75)	348( 9.65)	439(11.82)	435(12.12)	289( 9.94)	
<b>Marital</b>												0.01
Divorced	4224(10.50)	266( 9.55)	345( 9.56)	375(10.27)	395(10.83)	524(10.71)	531(10.61)	435(11.39)	530(11.23)	460( 9.76)	363(10.79)	
Widowed	3244( 5.74)	284(5.40)	335(5.73)	421(6.90)	317(5.94)	391(5.84)	392(5.91)	312(5.56)	302(5.54)	297(5.84)	193(4.61)	
Married	20698(57.60)	1664(60.02)	2221(61.45)	2013(58.97)	2040(59.23)	2423(57.44)	2452(57.59)	1910(54.09)	2284(57.67)	2121(55.76)	1570(54.63)	
Living with partner	2845( 7.48)	118(4.78)	209(6.18)	215(6.13)	285(8.28)	311(7.10)	369(7.63)	315(8.18)	301(6.40)	407(9.80)	315(9.57)	
Separated	1270( 2.43)	112(3.52)	121(2.52)	96(2.15)	113(2.34)	158(2.48)	150(2.30)	144(2.27)	128(2.09)	142(2.52)	106(2.45)	
Never married	6225(16.25)	410(16.72)	498(14.57)	546(15.58)	524(13.39)	681(16.43)	723(15.96)	824(18.51)	759(17.08)	718(16.32)	542(17.95)	
BMI	28.89(0.07)	28.17(0.24)	28.02(0.15)	28.28(0.18)	28.67(0.26)	28.68(0.13)	28.95(0.13)	28.96(0.23)	29.35(0.18)	29.58(0.27)	29.94(0.30)	< 0.0001
PIR	3.06(0.03)	2.93(0.12)	3.13(0.07)	3.02(0.08)	3.16(0.06)	3.08(0.09)	3.04(0.05)	2.97(0.10)	2.98(0.11)	3.05(0.11)	3.23(0.07)	0.21
<b>Smoke</b>												< 0.0001
now	8210(21.48)	590(25.19)	864(24.69)	841(25.25)	830(24.04)	1022(23.04)	1002(19.93)	816(20.02)	863(19.08)	800(18.27)	582(16.55)	
former	9909(25.42)	804(25.09)	1011(25.49)	1027(25.81)	977(25.54)	1159(24.90)	1186(25.40)	950(25.56)	1058(24.95)	1020(26.61)	717(24.71)	
never	20368(53.08)	1457(49.71)	1851(49.82)	1796(48.94)	1866(50.42)	2306(52.06)	2429(54.67)	2171(54.42)	2382(55.97)	2320(55.13)	1790(58.74)	
<b>Alcohol user</b>												< 0.0001
mild	12991(36.44)	895(33.38)	1279(35.39)	1162(33.55)	1179(34.70)	1371(34.72)	1504(35.82)	1328(37.35)	1481(36.09)	1378(36.59)	1414(46.91)	
moderate	5818(17.39)	390(16.91)	511(15.79)	497(16.13)	546(17.04)	644(15.70)	682(16.81)	588(17.02)	686(18.35)	633(18.25)	641(21.87)	
former	6877(14.50)	610(16.43)	711(16.37)	837(18.72)	787(17.28)	952(17.37)	843(15.41)	703(14.64)	750(14.44)	684(13.80)	0( 0.00)	
heavy	7581(20.96)	539(21.27)	702(19.95)	665(20.39)	704(20.59)	880(21.06)	1041(22.32)	794(21.28)	791(19.53)	793(20.15)	672(23.44)	
never	5239(10.71)	420(12.02)	526(12.50)	505(11.21)	458(10.40)	641(11.15)	547( 9.64)	527( 9.71)	596(11.58)	657(11.21)	362( 7.78)	
<b>Hypertension</b>												0.06
no	21773(62.22)	1599(65.20)	2195(65.84)	1981(61.34)	2146(62.90)	2498(62.54)	2633(62.54)	2230(61.11)	2438(59.66)	2324(60.78)	1729(61.64)	
yes	16723(37.76)	1255(34.80)	1529(34.16)	1682(38.66)	1527(37.10)	1990(37.46)	1983(37.46)	1710(38.89)	1866(40.34)	1821(39.22)	1360(38.36)	

<b>DM</b>												< 0.0001
no	28966(80.25)	2337(88.10)	3095(87.86)	2991(86.46)	2786(84.35)	3151(80.30)	3398(81.72)	2883(81.34)	3177(81.19)	2878(76.17)	2270(78.17)	
DM	6737(12.86)	397( 8.76)	486( 8.78)	540(10.69)	573(11.98)	873(14.52)	857(14.54)	754(14.53)	793(15.43)	877(16.93)	587(14.37)	
IFG	1693( 4.29)	120(3.14)	148(3.36)	135(2.85)	134(3.67)	231(5.18)	178(3.74)	143(4.12)	137(3.39)	235(6.90)	232(7.45)	
<b>Iron_mg</b>												< 0.0001
Q1	9645(22.66)	761(23.47)	866(20.93)	807(19.66)	791(19.47)	1103(21.25)	1098(21.10)	943(22.03)	1154(25.57)	1217(26.89)	905(26.00)	
Q2	9613(24.74)	716(25.18)	944(25.51)	901(23.31)	900(23.64)	1134(24.47)	1141(24.64)	960(23.74)	1093(25.52)	1041(25.80)	783(25.71)	
Q3	9622(26.02)	684(25.53)	968(26.40)	967(27.71)	909(25.67)	1145(26.79)	1218(27.83)	1001(24.99)	1039(24.93)	963(24.02)	728(26.63)	
Q4	9626(26.57)	693(25.81)	951(27.15)	991(29.32)	1074(31.22)	1106(27.49)	1160(26.42)	1036(29.23)	1018(23.99)	924(23.30)	673(21.66)	

Note: Data were presented as mean ± SD or n (%). DM: Diabetes Mellitus; BMI: Body Mass Index; PIR: Household Poverty-to-Income Ratio; Q1: Quartile 1; Q2: Quartile 2; Q3: Quartile 3; Q4: Quartile 4.

Table 2: Relationship between dietary iron intake and risk of mortality in different models<sup>a</sup>.

Character	Model1			p for trend	Model2			p for trend	Model3			p for trend
	HR	95% CI	P		HR	95% CI	P		HR	95% CI	P	
<b>All-cause mortality</b>				<b>&lt;0.001</b>				<b>&lt;0.001</b>				<b>0.004</b>
<b>iron_mg</b>												
Q1	-	-	-		-	-	-		-	-	-	
Q2	0.83	0.76-0.91	<0.001		0.85	0.78-0.92	<0.001		0.94	0.86-1.03	0.16	
Q3	0.69	0.63-0.76	<0.001		0.73	0.66-0.81	<0.001		0.84	0.75-0.94	0.003	
Q4	0.66	0.60-0.72	<0.001		0.71	0.63-0.78	<0.001		0.87	0.78-0.96	0.01	
<b>Cancer mortality</b>				<b>0.005</b>				<b>0.003</b>				<b>0.028</b>
<b>iron_mg</b>												
Q1	-	-	-		-	-	-		-	-	-	
Q2	0.85	0.71-1.02	0.08		0.86	0.71-1.04	0.12		0.89	0.73-1.09	0.27	
Q3	0.78	0.64-0.96	0.02		0.79	0.65-0.96	0.02		0.85	0.73-1.09	0.14	
Q4	0.75	0.61-0.91	0.004		0.73	0.59-0.90	0.003		0.76	0.73-1.09	0.02	
<b>Heart disease mortality</b>				<b>0.176</b>				<b>&lt;0.001</b>				<b>0.05</b>

<b>iron_mg</b>									
Q1	-	-	-	-	-	-	-	-	-
Q2	1.14	0.94-1.40	0.19	0.85	0.71-1.01	0.07	0.99	0.82-1.20	0.94
Q3	1.02	0.81-1.27	0.88	0.68	0.57-0.80	<0.001	0.79	0.65-0.96	0.02
Q4	1.29	0.98-1.70	0.07	0.63	0.52-0.78	<0.001	0.84	0.66-1.07	0.15
<b>Respiratory disease mortality</b>			<b>0.09</b>			<b>&lt;0.001</b>			<b>&lt;0.001</b>
<b>iron_mg</b>									
Q1	-	-	-	-	-	-	-	-	-
Q2	1.55	1.05-2.30	0.03	0.83	0.61-1.15	0.26	1.03	0.73-1.46	0.87
Q3	1.44	0.86-2.42	0.17	0.57	0.39-0.84	0.004	0.68	0.46-1.01	0.06
Q4	1.86	0.98-3.53	0.06	0.4	0.28-0.58	<0.001	0.56	0.39-0.81	0.002
<b>Cerebrovascular disease mortality</b>			<b>0.874</b>			<b>0.034</b>			<b>0.528</b>
<b>iron_mg</b>									
Q1	-	-	-	-	-	-	-	-	-
Q2	0.97	0.62-1.51	0.88	0.94	0.67-1.33	0.73	0.92	0.62-1.38	0.69
Q3	0.9	0.59-1.38	0.62	0.68	0.48-0.98	0.04	0.83	0.57-1.21	0.34
Q4	0.98	0.55-1.75	0.95	0.73	0.50-1.06	0.1	0.9	0.58-1.38	0.62
<b>Influenza and pneumonia mortality</b>			<b>0.765</b>			<b>0.138</b>			<b>0.547</b>
<b>iron_mg</b>									
Q1	-	-	-	-	-	-	-	-	-
Q2	1.08	0.51-2.32	0.84	0.77	0.41-1.45	0.42	0.93	0.47-1.84	0.83
Q3	1	0.42-2.38	1	0.66	0.34-1.28	0.22	0.76	0.38-1.54	0.45
Q4	1.25	0.42-3.69	0.69	0.58	0.28-1.18	0.13	0.84	0.40-1.75	0.64
<b>DM mortality</b>			<b>0.446</b>			<b>0.531</b>			<b>0.298</b>
<b>iron_mg</b>			<b>0.446</b>			<b>0.531</b>			<b>0.298</b>

Q1	-	-	-	-	-	-	-	-	-
Q2	0.9	0.51- 1.59	0.71	1.05	0.64-1.71	0.85	0.89	0.50- 1.56	0.67
Q3	0.67	0.36- 1.24	0.2	0.59	0.37-0.96	0.03	0.67	0.36- 1.23	0.19
Q4	1.52	0.74- 3.11	0.25	0.96	0.57-1.62	0.89	1.46	0.84- 2.54	0.18
<b>Kidney disease mortality</b>			<b>0.258</b>			<b>0.58</b>			<b>0.881</b>
Q1	-	-	-	-	-	-	-	-	-
Q2	0.53	0.30-0.94	0.03	0.56	0.32-0.99	0.04	0.67	0.36-1.23	0.2
Q3	0.5	0.30-0.85	0.01	0.56	0.33-0.95	0.03	0.69	0.40-1.18	0.18
Q4	0.72	0.46-1.14	0.16	0.84	0.52-1.37	0.49	1.05	0.58-1.89	0.88
<b>Alzheimer mortality</b>			<b>0.63</b>			<b>0.63</b>			<b>0.25</b>
Q1	-	-	-	-	-	-	-	-	-
Q2	0.82	0.54-1.26	0.37	0.94	0.62-1.42	0.77	0.96	0.62-1.49	0.84
Q3	0.95	0.60-1.49	0.81	1.17	0.74-1.86	0.49	1.19	0.71-2.00	0.5
Q4	0.84	0.54-1.32	0.46	1.25	0.78-1.99	0.36	1.45	0.86-2.43	0.16

Note: -: Data were adjusted for NHANES survey weights; Model 1 was not adjusted for any covariates; Model 2 was adjusted for age, sex, and race; Model 3 was further adjusted for other covariates, including PIR, education level, smoking status, alcohol use, hypertension and DM; HR: Hazard Ratio; CI: Confidence Interval.

**Table 3:** The association between dietary iron intakes with all-cause mortality in different subgroups<sup>a</sup>

Characters	Q1	Q2	p	Q3	p	Q4	p	p for trend
<b>Age</b>								
<= 65 years	-	0.86(0.74-1.01)	0.07	0.75(0.64-0.88)	<0.001	0.76(0.64-0.91)	0.002	0.001
>65 years	-	0.98(0.86-1.11)	0.75	0.90(0.78-1.05)	0.17	0.94(0.83-1.08)	0.4	0.27
<b>Sex</b>								
Male	-	0.94(0.80-1.09)	0.4	0.85(0.73-0.99)	0.03	0.83(0.71-0.98)	0.03	0.02
Female	-	0.94(0.82-1.06)	0.3	0.81(0.69-0.96)	0.02	0.93(0.79-1.10)	0.4	0.1
<b>Race</b>								

Non-Hispanic White	-	0.91(0.81-1.02)	0.11	0.83(0.72-0.96)	0.01	0.85(0.75-0.97)	0.02	0.02
Mexican American	-	1.00(0.75-1.35)	0.99	1.05(0.77-1.43)	0.78	0.80(0.59-1.07)	0.14	0.19
Other Race - Including Multi-Racial	-	1.86(1.12-3.09)	0.02	1.54(0.85-2.79)	0.16	1.19(0.64-2.22)	0.57	0.91
Non-Hispanic Black	-	0.92(0.75-1.12)	0.41	0.72(0.60-0.87)	<0.001	0.73(0.57-0.93)	0.01	<0.001
Other Hispanic	-	0.71(0.41-1.22)	0.21	0.78(0.48-1.28)	0.33	1.15(0.65-2.06)	0.63	0.67
<b>Smoke</b>								
Now	-	1.05(0.88-1.26)	0.58	0.93(0.75-1.16)	0.53	0.82(0.64-1.07)	0.14	0.12
Former	-	0.85(0.74-0.99)	0.04	0.80(0.67-0.96)	0.02	0.82(0.70-0.97)	0.02	0.03
Never	-	0.96(0.82-1.11)	0.57	0.79(0.66-0.95)	0.01	0.91(0.77-1.07)	0.26	0.08
<b>Alcohol user</b>								
Mild	-	0.97(0.82-1.15)	0.75	0.86(0.71-1.04)	0.12	0.90(0.75-1.08)	0.24	0.16
Moderate	-	0.70(0.53-0.92)	0.01	0.48(0.35-0.67)	<0.0001	0.53(0.39-0.72)	<0.0001	<0.0001
Former	-	0.87(0.73-1.03)	0.11	0.93(0.78-1.12)	0.45	0.85(0.69-1.04)	0.11	0.2
Heavy	-	1.02(0.72-1.45)	0.9	0.79(0.52-1.18)	0.24	0.71(0.52-0.96)	0.02	0.01
Never	-	1.13(0.90-1.43)	0.3	0.81(0.63-1.04)	0.09	1.24(0.97-1.59)	0.09	0.54
<b>Hypertension</b>								
No	-	0.82(0.68-1.00)	0.05	0.74(0.60-0.90)	0.003	0.73(0.60-0.90)	0.003	0.003
Yes	-	0.97(0.87-1.08)	0.55	0.87(0.76-1.00)	0.05	0.91(0.81-1.03)	0.13	0.06
<b>DM</b>								
No	-	0.97(0.86-1.10)	0.61	0.85(0.74-0.98)	0.03	0.83(0.72-0.97)	0.02	0.01
DM	-	0.93(0.78-1.11)	0.42	0.87(0.70-1.08)	0.2	1.02(0.85-1.22)	0.83	0.95
IFG	-	0.72(0.48-1.08)	0.11	0.77(0.54-1.08)	0.13	0.71(0.49-1.02)	0.07	0.1

Note: IFG: Impaired Fasting Glucose; <sup>a</sup>: Data were adjusted for NHANES survey weights