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Statistical Analysis of BMI and Blood Pressure Variations Across Age Groups and Genders: An ANOVA-Based Study in Dhanbad District, Jharkhand

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Abstract:
The present study investigates the influence of age and gender on Body Mass Index (BMI), Systolic Blood Pressure (SBP), and Diastolic Blood Pressure (DBP) in adults from Dhanbad District, Jharkhand, using ANOVA-based statistical analysis. Significant differences in BMI and SBP were observed across age groups ($p < 0.05$), with older age groups showing higher values, suggesting age-related physiological influences on these measures. Conversely, DBP did not differ significantly with age ($p > 0.05$), indicating relative stability across age groups. Gender analysis revealed significant differences in both SBP and DBP ($p < 0.05$), with males exhibiting higher blood pressure levels than females, while BMI showed no significant gender-based differences. Effect size measures (η^2) indicated moderate associations between age and BMI/SBP, and smaller but significant associations between gender and blood pressure. These findings highlight the importance of considering both age and gender in cardiovascular risk assessment and suggest that targeted interventions should be tailored accordingly to address age- and gender-specific variations in blood pressure and BMI.
Keywords: BMI, Blood Pressure, ANOVA, Age Groups, Gender Differences, Systolic Pressure, Diastolic Pressure, Statistical Analysis, Health Risk Factors, Demographic Study.

1. Introduction

Body Mass Index (BMI) and blood pressure are two critical indicators of an individual's overall health and risk of developing chronic diseases[1-3]. With increasing age, changes in body composition and cardiovascular function contribute to variations in BMI and blood pressure[4]. Additionally, gender differences play a significant role in determining these health parameters due to physiological and hormonal differences[5].

Previous studies have established that age-related weight gain and changes in metabolic rate impact BMI trends over time[6-9]. Similarly, blood pressure tends to increase with age due to arterial stiffness and other cardiovascular factors[10]. Gender-related differences in BMI and blood pressure have also been widely reported, with males and females exhibiting distinct physiological patterns influenced by hormonal and lifestyle factors[11-15].

Obesity and hypertension are critical public health challenges linked to aging and gender disparities. While prior studies highlight age-related metabolic decline and gender-specific cardiovascular risks, regional data from rural India remain sparse. This study examines BMI and blood pressure trends across age and gender in Dhanbad District, Jharkhand, to

inform targeted interventions.

The purpose of this study is to examine the variations in BMI and blood pressure (systolic and diastolic) across different age groups and genders using Analysis of Variance (ANOVA). Understanding these variations can provide valuable insights into potential health risks, allowing for better-targeted healthcare interventions.

By applying ANOVA, this study aims to determine whether significant differences exist in BMI and blood pressure across age groups and gender categories. The findings will contribute to a better understanding of health trends and may help in designing age- and gender-specific preventive healthcare strategies.

2. Methods

2.1. Study Design and Participants

A cross-sectional study was conducted with 142 participants (**53 male, 89 female**) aged 15–85 years, recruited via stratified random sampling. Exclusion criteria included pregnancy, chronic illness, and medication affecting blood pressure

2.2. **Anthropometric Data:** Weight (kg) and height (m) were measured using calibrated instruments. BMI was calculated using the standard formula:

$$BMI = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

2.3. **Blood Pressure:** Systolic (SBP) and diastolic (DBP) pressures were recorded using standardized sphygmomanometers after 10 minutes of rest.

2.4. Study Area and Population

This cross-sectional study was conducted in Dhanbad District, Jharkhand, India, a region characterized by its urban-rural mix and industrial activity, which may influence lifestyle-related health metrics. Participants were recruited from community health centers, residential neighborhoods, and local workplaces to ensure demographic diversity. The study population included adults aged 12–80 years, stratified into six age groups: <20, 20–30, 31–40, 41–50, 51–60, and >60 years. A total of 142 participants (53 males, 89 females) were enrolled

This study was conducted in the Dhanbad District of Jharkhand, involving 142 participants from various age groups, with their details summarized in Table 1

Table 1 Summary of Age, Gender, Weight, Height, Blood Pressure (Systolic/Diastolic), and Body Mass Index (BMI) of 142 Participants from Dhanbad District, Jharkhand

AGE	GENDER	WEIGHT(KG)	HEIGHT	BLOOD P.	BMI
24	F	58.14	5' 2"	111/72	23.4
20	F	44.13	5' 1"	124/67	18.3
45	F	61.15	5' 3"	109/65	23.8
20	F	49.1	5' 4"	118/71	18.5
16	M	57.9	5' 6"	125/75	20.3
65	F	44.16	4' 10"	117/71	20.3
35	M	69.13	5' 1"	126/89	28.7
30	M	42.11	5' 0"	126/81	18.1
16	M	41.14	5' 1"	125/71	17.1
54	M	54.9	5' 2"	112/76	21.8
19	F	40.5	5'	116/74	17.2
50	F	34.17	5' 9"	116/74	16.2

AGE	GENDER	WEIGHT(KG)	HEIGHT	BLOOD P.	BMI
45	F	52.5	5' 2"	105/74	21
28	M	57.16	5' 8"	117/72	19.1
38	F	53.18	4' 9"	119/83	25.3
40	M	68.12	5' 3"	126/82	26.6
65	F	44.12	4' 6"	129/77	23.4
17	F	47.15	5' 0"	120/77	20.2
46	F	63.4	5' 5"	138/89	23.1
24	F	61.3	5' 2"	127/83	24.6
27	M	50.15	5' 7"	112/78	17.3
18	F	51.21	5' 2"	113/74	20.6
33	M	69.4	5' 3"	142/91	27.1
54	M	57.5	5' 1"	176/96	24
52	F	37.2	4' 8"	129/75	18.4
43	F	55.45	5' 1"	114/65	23.1
34	F	36.25	4' 8"	94/67	17.9
25	F	49	5' 0"	109/73	21.1
19	M	47.8	5' 2"	127/88	19.3
20	M	50.8	5' 7"	126/82	17.5
22	F	53.85	5'	127/81	23.2
45	F	39.8	4' 10"	121/78	18
49	F	43	4' 11"	120/75	19.1
50	M	52.5	5' 3"	134/88	20.5
55	M	50	5' 4"	110/50	18.9
38	F	40.85	4' 10"	103/67	18.8
27	F	46.5	4' 11"	104/63	20.7
35	F	40	4' 8"	92/61	19.8
32	M	49.52	5' 3"	128/95	19.3
50	F	45.2	4' 9"	153/83	21.6
40	M	55.12	5' 0"	113/82	23.7
38	F	44.12	4' 9"	120/77	21.2
37	F	45.5	4' 9"	103/65	21.7
40	M	55.7	5' 5"	107/67	20.4
46	F	51.65	5' 0"	116/64	22.2
36	F	39	4' 10"	101/77	18
30	F	52.1	4' 8"	106/74	25.8
47	F	46.3	5' 2"	121/68	18.7
25	F	60.21	5' 3"	104/58	23.5
45	M	69.35	5' 3"	148/107	27.1

AGE	GENDER	WEIGHT(KG)	HEIGHT	BLOOD P.	BMI
36	F	71	5' 3"	136/97	27.7
75	M	43.25	5' 2"	124/41	17.4
85	F	31.33	4' 10"	98/45	14.4
62	F	42.61	4' 9"	151/97	20.3
32	M	76.51	5' 0"	154/100	32.9
48	M	68.53	5' 4"	127/86	25.9
50	M	68.49	5' 5"	119/87	25.1
74	M	48.12	5' 3"	98/42	18.8
65	F	49.32	5' 0"	115/62	21.2
45	F	43.12	5' 0"	90/42	18.5
45	F	40.21	4' 9"	123/49	19.2
40	M	53.12	5' 2"	96/55	21.4
20	M	73.33	5' 4"	141/86	27.6
23	M	56.21	5' 8"	110/68	18.8
80	F	30.11	4' 6"	85/42	16
43	F	61.1	4' 11"	121/78	27.2
44	M	46.6	5' 2"	73/30	18.8
41	M	54.23	5' 3"	122/65	21.2
19	M	59.1	5' 6"	135/87	21
26	M	80.12	5 9"	116/79	26.1
27	M	56.21	5' 6"	109/57	20
44	M	67.14	5' 1"	144/104	28
40	F	57.42	5' 0"	120/81	24.7
21	M	53.25	5' 5"	132/82	19.5
25	F	54.12	4' 9"	114/74	25.8
36	F	32.13	4' 8"	80/45	15.8
43	F	43.61	4' 10"	118/69	20.1
46	M	45.2	5' 1"	114/86	18.7
30	F	56.1	4' 11"	120/78	24.9
29	F	56	5' 3"	138/82	21.9
15	F	44.9	5' 2"	104/55	19.4
30	M	68.41	5' 7"	117/74	23.6
73	M	54.62	5' 3"	149/106	21.3
18	F	35.1	5' 0"	106/76	15.1
24	M	64.23	5' 5"	131/79	23.5
21	F	39.12	5' 2"	109/62	15.7
41	M	53.51	5' 4"	129/91	20.1
25	F	54.55	5' 3"	113/76	21.3

AGE	GENDER	WEIGHT(KG)	HEIGHT	BLOOD P.	BMI
25	F	59.91	5' 0"	123/88	25.8
24	F	47.35	4' 11"	107/76	21.1
25	M	54.71	5' 7"	109/66	18.9
17	F	37.69	4' 8"	109/66	18.6
60	F	48.12	5' 00"	116/65	20.7
30	M	57.85	5' 9"	120/81	18.8
46	F	53.45	5' 2"	135/83	21.6
62	F	45.51	4' 11"	167/97	20.3
22	F	41.15	4' 9"	125/90	19.6
26	M	54.31	5' 7"	133/85	18.7
24	F	36.87	4' 10"	98/67	17
40	F	60.3	4' 10"	125/82	27.8
66	M	49.25	5' 2"	106/99	19.9
62	M	41.45	5' 2"	176/80	16.7
65	F	45.35	4' 9"	136/85	21.6
58	F	42.29	4' 11"	112/66	18.8
45	F	32.2	4' 9"	120/48	15.4
48	F	43.25	4' 10"	107/60	19.9
40	F	52.25	4' 10"	121/79	24.1
60	M	49.81	5' 2"	135/85	20.1
53	F	36.89	4' 7"	137/76	18.9
58	M	66.9	5' 3"	102/70	26.1
52	F	39.94	4' 11"	112/73	17.8
65	F	40.41	4' 10"	142/72	18.6
21	F	32.3	4' 9"	91/68	15.4
43	F	45.75	5' 0"	120/77	19.7
28	F	44.11	5' 0"	118/67	19
36	F	66.95	5' 1"	124/84	27.9
50	F	61.65	5' 0"	136/83	26.5
46	F	42.95	4' 9"	119/66	20.5
24	F	52.35	5' 3"	126/76	20.4
50	F	42.95	4' 8"	136/83	21.2
29	F	38.15	4' 8"	121/62	18.9
58	M	50.91	5' 4"	98/44	19.3
35	M	59.61	5' 3"	121/87	23.3
21	F	45.41	5' 2"	98/53	18.3
27	M	54.71	5' 5"	108/64	20.1
21	F	43.78	5' 0"	113/75	18.8

AGE	GENDER	WEIGHT(KG)	HEIGHT	BLOOD P.	BMI
25	F	43.31	4' 10"	98/52	20.1
29	M	49.82	5' 2"	112/73	20.1
70	M	56.75	5' 5"	161/98	20.8
65	F	31.76	5' 0"	140/87	13.7
55	F	45.12	5' 00"	91/33	19.4
40	F	42.85	4' 11"	127/81	19.1
41	F	46.55	5' 1"	100/70	19.4
50	F	59.25	4' 11"	120/78	26.4
27	F	52.1	5' 1"	116/72	21.7
28	M	70.5	5' 1"	127/70	29.4
19	M	47.71	5' 00"	106/53	20.5
35	F	44.12	4' 11"	97/66	19.9
55	F	58.75	4' 11"	133/75	26.2
65	M	59.4	5' 00"	136/72	25.6
40	F	61.7	4' 11"	129/84	27.6
50	F	53.45	4' 11"	116/66	23.8

3. Result and Discussion

3.1. Data Grouping and Analysis

Participants were categorized into six distinct age groups: <20, 20–30, 31–40, 41–50, 51–60, and >60 years to facilitate age-specific comparisons. Analysis of Variance (ANOVA) tests were conducted to compare Body Mass Index (BMI), Systolic Blood Pressure (SBP), and Diastolic Blood Pressure (DBP) across these age groups as well as between genders. To effectively examine variations in BMI across different age categories, the data were stratified into the aforementioned six age brackets. This grouping enabled a focused assessment of BMI trends in relation to age.

3.2. BMI Values Across Age Groups

As presented in Table 2, the mean BMI showed a gradual increase from the <20 years group, reaching a peak within the 31–40 years group, followed by a decline in the older age categories. This observed pattern offers valuable insights into age-related changes in BMI, which may be influenced by factors such as metabolism, lifestyle, or overall health status.

Table 2 **BMI Values Across Age Groups**

Group	**Data**	**n**	**Mean**
<20 years	20.3, 17.1, 17.2, 20.2, 20.6, 19.3, 21, 19.4, 15.1, 18.6, 20.5	11	19.03±1.47
20–30 years	23.4, 18.3, 18.5, 18.1, 19.1, 24.6, 17.3, 21.1, 17.5, 23.2, 20.7, 25.8, 23.5, 27.6, 18.8, 26.1, 20, 19.5, 25.8, 24.9, 21.9, 23.6, 23.5, 15.7, 21.3, 25.8, 21.1, 18.9, 18.8, 19.6, 18.7, 17, 15.4, 19, 20.4, 18.9, 18.3, 20.1, 18.8, 20.1, 20.1, 21.7, 29.4	43	20.97±2.64
31–40 years	28.7, 25.3, 26.6, 27.1, 17.9, 18.8, 19.8, 19.3, 23.7, 21.2, 21.7, 20.4, 18, 27.7, 32.9, 21.4, 24.7, 15.8, 27.8, 24.1, 27.9, 23.3, 19.1, 19.9, 27.6	25	23.23±3.63

41–50 years	23.8, 16.2, 21, 23.1, 23.1, 18, 19.1, 20.5, 21.6, 22.2, 18.7, 27.1, 25.9, 25.1, 18.5, 19.2, 27.2, 18.8, 21.2, 28, 20.1, 18.7, 20.1, 21.6, 15.4, 19.9, 19.7, 26.5, 20.5, 21.2, 19.4, 26.4, 23.8	33	21.56±2.64
51–60 years	21.8, 24, 18.4, 18.9, 20.7, 18.8, 20.1, 18.9, 26.1, 17.8, 19.3, 19.4, 26.2	13	20.80±2.29
>60 years	20.3, 23.4, 17.4, 14.4, 20.3, 18.8, 21.2, 16, 21.3, 20.3, 19.9, 16.7, 21.6, 18.6, 20.8, 13.7, 25.6	17	19.43±2.40

3.3. BMI Distribution by Gender

BMI data were analyzed across genders to explore potential differences in body composition. The sample included 53 males and 89 females. The average BMI was slightly higher in males (21.79 ± 3.10) compared to females (20.78 ± 2.62) shown in Table3.

Males showed greater variability in BMI, possibly reflecting differences in muscle mass and body composition. While underweight cases were more common among females (14%) than males (9%), both groups included outliers—one male with a BMI of 32.9 and one female with a BMI of 13.7—indicating potential health concerns.

Table 3: BMI Values Across Gender

Gender	BMI Values	n	Mean BMI
Male	20.3, 28.7, 18.1, 17.1, 21.8, 19.1, 26.6, 17.3, 27.1, 24.0, 19.3, 17.5, 20.5, 18.9, 19.3, 23.7, 20.4, 27.1, 17.4, 32.9, 25.9, 25.1, 18.8, 21.4, 27.6, 18.8, 18.8, 21.2, 21.0, 26.1, 20.0, 28.0, 19.5, 18.7, 23.6, 21.3, 23.5, 20.1, 18.9, 18.8, 18.7, 19.9, 16.7, 20.1, 26.1, 19.3, 23.3, 20.1, 20.1, 20.8, 29.4, 20.5, 25.6	53	**21.79± 3.10**
Female	23.4, 18.3, 23.8, 18.5, 20.3, 17.2, 16.2, 21.0, 25.3, 23.4, 20.2, 23.1, 24.6, 20.6, 18.4, 23.1, 17.9, 21.1, 23.2, 18.0, 19.1, 18.8, 20.7, 19.8, 21.6, 21.2, 21.7, 22.2, 18.0, 25.8, 18.7, 23.5, 27.7, 14.4, 20.3, 21.2, 18.5, 19.2, 16.0, 27.2, 24.7, 25.8, 15.8, 20.1, 24.9, 21.9, 19.4, 15.1, 15.7, 21.3, 25.8, 21.1, 18.6, 20.7, 21.6, 20.3, 19.6, 17.0, 27.8, 21.6, 18.8, 15.4, 19.9, 24.1, 18.9, 17.8, 18.6, 15.4, 19.7, 19.0, 27.9, 26.5, 20.5, 20.4, 21.2, 18.9, 18.3, 18.8, 20.1, 13.7, 19.4, 19.1, 19.4, 26.4, 21.7, 19.9, 26.2, 27.6, 23.8	89	**20.78± 2.62**

3.4. Blood Pressure Analysis

3.4.1. Systolic Blood Pressure Across Age Groups

Systolic blood pressure (SBP) exhibited an age-associated upward trend across the sample. The youngest group (<20 years) had the lowest mean SBP (115.20 ± 11.01 mmHg), while the highest average was observed in individuals over 60 years (129.05 ± 19.76 mmHg), reflecting typical age-related vascular changes presented in Table3.

SBP remained relatively stable in the 20–50 year age range, with modest increases seen in the 31–50 year groups (mean SBP ~120 mmHg). However, the 51–60 year group showed a sharper rise (125.23 ± 12.21 mmHg), which became more pronounced in those above 60, who also displayed the widest variability, suggesting the influence of comorbidities or antihypertensive treatment.

This progressive rise in SBP with age aligns with known physiological trends and underscores the need for regular monitoring in older populations. Interventions to manage blood pressure could be more targeted in the >50 age groups to mitigate cardiovascular risk.

Table 4 **Systolic Blood Pressure Across Age Groups**

Group	Systolic Blood Pressure (SBP)	n	Mean SBP
<20 years	125, 125, 116, 120, 113, 127, 135, 104, 106, 109, 141, 104, 106, 91, 106	15	115.20±11.01
20–30 years	111, 124, 118, 126, 126, 117, 116, 117, 127, 112, 113, 109, 127, 126, 127, 132, 114, 109, 113, 123, 107, 109, 109, 120, 120, 117, 131, 109, 121, 98, 121, 98, 108, 113, 98, 112	36	116.06±7.28
31–40 years	126, 126, 117, 119, 126, 142, 94, 103, 104, 92, 128, 103, 120, 101, 106, 136, 154, 120, 117, 138, 120, 127, 138, 120, 121, 127, 116, 127, 124, 118, 121, 118, 124, 127	34	120.59±9.53
41–50 years	109, 116, 105, 126, 138, 114, 121, 120, 134, 114, 148, 144, 120, 100, 129, 120, 73, 122, 120, 123, 96, 144, 120, 129	24	120.21±11.31
51–60 years	116, 129, 110, 153, 136, 119, 136, 136, 91, 120, 133, 116, 133	13	125.23±12.21
>60 years	117, 129, 124, 98, 151, 98, 115, 123, 98, 149, 161, 140, 136, 106, 176, 142, 167, 137, 102, 112	20	129.05±19.76

3.4.2. Diastolic Blood Pressure Across Age Groups

Analysis of diastolic blood pressure (DBP) across age groups reveals a less consistent age-related pattern compared to systolic pressure. The youngest age group (<20 years) had a mean DBP of 71.33 ± 7.24 mmHg, with relatively narrow variability summarized in Table4.

DBP increased slightly in the 20–30 years group to 73.64 ± 8.09 mmHg, and peaked in the 41–50 years group at 78.29 ± 12.02 mmHg, indicating a mid-life elevation, potentially linked to rising vascular resistance and lifestyle factors.

A mild decline was noted thereafter in the 51–60 years (73.54 ± 11.41 mmHg) and >60 years (73.45 ± 16.75 mmHg) groups. The elderly group also showed the widest standard deviation (±16.75 mmHg), pointing to substantial inter-individual variation, likely due to underlying health conditions or the effects of antihypertensive treatments.

Table 5. Diastolic Blood Pressure (DBP) by Age Group

Group	Diastolic Blood Pressure (DBP)	n	Mean DBP
<20 years	75, 71, 74, 77, 74, 88, 86, 55, 76, 66, 66, 68, 53, 75, 66	15	71.33±7.24
20–30 years	72, 67, 71, 81, 81, 72, 83, 82, 83, 78, 74, 91, 73, 88, 82, 81, 74, 62, 76, 88, 76, 66, 66, 81, 78, 74, 79, 62, 62, 44, 87, 53, 64, 75, 52, 73	36	73.64±8.09
31–40 years	89, 81, 72, 83, 82, 91, 67, 67, 63, 61, 95, 65, 77, 77, 74, 97, 100, 77, 74, 82, 70, 70, 82, 81, 87, 72, 84, 67, 87, 66, 87, 53, 64, 75	34	77.03± 8.97
41–50 years	65, 74, 74, 82, 89, 65, 78, 75, 88, 86, 107, 104, 81, 70, 91, 66, 30, 65, 79, 88, 55, 104, 79, 84	24	78.29±12.02
51–60 years	65, 75, 50, 83, 97, 87, 83, 83, 33, 78, 75, 72, 75	13	73.54±11.41
>60 years	71, 77, 41, 45, 97, 42, 62, 49, 42, 106, 98, 87, 85, 99, 80, 72, 97, 76, 70, 73	20	73.45±16.75

Males exhibited a higher mean systolic blood pressure (123.96 ± 14.04 mmHg) compared to females (116.87 ± 11.56 mmHg), indicating gender-based variation in SBP, with males showing both higher average values and greater variability.

Table 6: Systolic Blood Pressure (SBP) across gender

Gender	Data of Systolic Blood Pressure (SBP)	n	Mean SBP
Male	125, 126, 126, 125, 112, 117, 126, 112, 142, 176, 127, 126, 134, 110, 128, 113, 107, 148, 124, 154, 127, 119, 98, 96, 141, 110, 73, 122, 135, 116, 109, 144, 132, 114, 117, 149, 131, 129, 109, 120, 133, 106, 176, 135, 102, 98, 121, 108, 112, 161, 127, 106, 136	53	123.96±14.04
Female	111, 124, 109, 118, 117, 116, 116, 105, 119, 129, 120, 138, 127, 113, 129, 114, 94, 109, 127, 121, 120, 103, 104, 92, 153, 120, 103, 116, 101, 106, 121, 104, 136, 98, 151, 115, 90, 123, 85, 121, 120, 114, 80, 118, 120, 138, 104, 106, 109, 113, 123, 107, 109, 116, 135, 167, 125, 98, 125, 136, 112, 120, 107, 121, 137, 112, 142, 91, 120, 118, 124, 136, 119, 126, 136, 121, 98, 113, 98, 140, 91, 127, 100, 120, 116, 97, 133, 129, 116	89	116.87±11.56

While Males had a higher mean diastolic blood pressure (77.40 ± 13.12 mmHg) compared to females (71.49 ± 9.41 mmHg), reflecting both elevated average values and greater variability in DBP among males.

Figure 1 presents a violin plot illustrating the distribution of systolic blood pressure (SBP) across male and female participants. The plot combines a boxplot with a kernel density estimation to show both the central tendency and the spread of the data.

From the figure, it is evident that males tend to have a higher median SBP compared to females. The distribution in males also appears slightly more spread out, with a wider interquartile range and more variation in higher SBP values

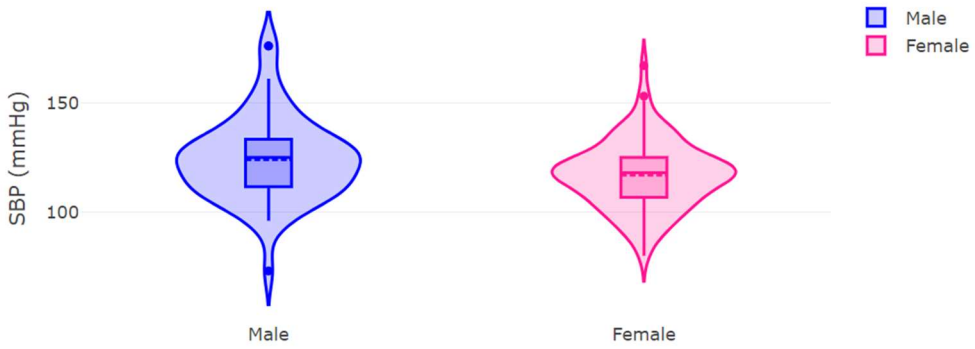

Figure 1Figure 1: Violin Plot of Systolic Blood Pressure (SBP) by Gender

Table 7. Diastolic Blood Pressure (DBP) across gender

Gender	Data of Diastolic Blood Pressure (DBP)	n	Mean DBP
Male	75, 89, 81, 71, 76, 72, 82, 78, 91, 96, 88, 82, 88, 50, 95, 82, 67, 107, 41, 100, 86, 87, 42, 55, 86, 68, 30, 65, 87, 79, 57, 104, 82, 86, 74, 106, 79, 91, 66, 81, 85, 99, 80, 85, 70, 44, 87, 64, 73, 98, 70, 53, 72	53	77.40±13.12
Female	72, 67, 65, 71, 71, 74, 74, 74, 83, 77, 77, 89, 83, 74, 75, 65, 67, 73, 81, 78, 75, 67, 63, 61, 83, 77, 65, 64, 77, 74, 68, 58, 97, 45, 97, 62, 42, 49, 42, 78, 81, 74, 45, 69, 78, 82, 55, 76, 62, 76, 88, 76, 66, 65, 83, 97, 90, 67, 82, 85, 66, 48, 60, 79, 76, 73, 72, 68, 77, 67, 84, 83, 66, 76, 83, 62, 53, 75, 52, 87, 33, 81, 70, 78, 72, 66, 75, 84, 66	89	71.49±9.41

Among 142 participants, males (n=53) had a higher mean systolic (123.96 ± 14.04 mmHg; range: 73–176) and diastolic

blood pressure (77.40 ± 13.12 mmHg; range: 30–107) compared to females (n=89), who showed lower mean systolic (116.87 ± 11.56 mmHg; range: 80–167) and diastolic (71.49 ± 9.41 mmHg; range: 33–97) values.

Figure 2 illustrates the distribution of diastolic blood pressure (DBP) among male and female participants using a violin plot. This visualization integrates a boxplot with a density trace to effectively capture the central values and variability of DBP for each gender group.

The plot reveals that males generally exhibit higher median DBP values compared to females. Additionally, the male group shows a wider spread and more variability, with a few lower outliers, indicating greater dispersion in DBP readings. In contrast, the distribution in females is narrower, suggesting more uniformity in DBP values.

These differences support the statistical analysis results, which identified a significant variation in DBP across genders

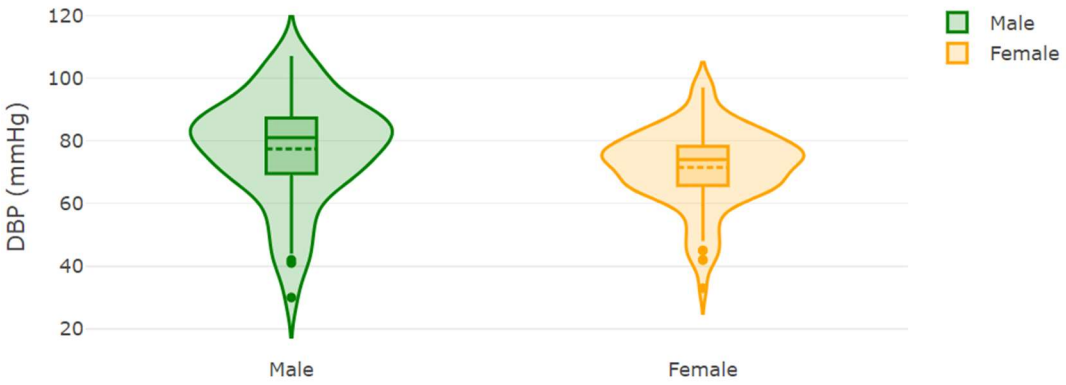

Figure 2: Violin Plot of Diastolic Blood Pressure (DBP) by Gender

Table 8. Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) Values Across Gender (n = 142)

Gender	Participants (n)	SBP Mean ± SD (mmHg)	SBP Range (mmHg)	DBP Mean ± SD (mmHg)	DBP Range (mmHg)
Male	53	123.96±**14.04**	73-176	77.40±**13.12**	30-107
Female	89	116.87±**11.56**	80-167	71.49±**9.41**	33-97

The analysis of Systolic and Diastolic Blood Pressure (SBP and DBP) across different age groups and genders reveals several important trends relevant to public health and clinical screening.

Systolic blood pressure (SBP) increased steadily with age, from a mean of 116.9 mmHg in individuals under 20 to 131.2 mmHg in those over 60, reflecting age-related arterial stiffening. Diastolic blood pressure (DBP) peaked in the 31–40 age group (77.8 mmHg) and showed a slight decline in older groups, possibly due to reduced arterial compliance. Both SBP and DBP variability (standard deviation and range) increased with age, indicating greater cardiovascular heterogeneity among older adults.

Table9. Summary of Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) Mean, Standard Deviation, and Range across Different Age Groups with Corresponding Number of Participants (n).

Age Group	Participants (n)	SBP Mean ± SD (mmHg)	SBP Range (mmHg)	DBP Mean ± SD (mmHg)	DBP Range (mmHg)
<20	11	116.9 ± 9.8	104 - 135	72.4 ± 10.6	53 - 88
20–30	43	116.4 ± 11.0	91 - 141	73.0 ± 9.0	52 - 90

31–40	25	116.2 ± 16.9	80 - 154	77.8 ± 13.0	45 - 100
41–50	33	120.7 ± 15.6	73 - 153	73.7 ± 16.1	30 - 107
51–60	13	120.2 ± 21.2	91 - 176	68.0 ± 16.3	33 - 96
>60	17	131.2 ± 25.0	85 - 176	74.9 ± 21.3	41 - 106

Table 10 shows that BMI and SBP significantly vary across age groups (p = 0.0025 and 0.0323, η^2 = 12.5% and 8.5%, respectively), while DBP does not (p = 0.5947). Gender differences are significant for SBP and DBP (p = 0.0160 and 0.0184, $\eta^2 \approx 4\%$), but not for BMI (p = 0.0970). Overall, age strongly influences BMI and SBP, and gender significantly affects blood pressure measures.

Table 30. ANOVA Summary for BMI and Blood Pressure Across Age Groups and Gender

Anova Test	Source	Degrees of Freedom (DF)	Sum of Squares (SS)	Mean Square (MS)	F-Statistic	P-Value	Eta-squared (η^2):	Interpretation
BMI Across Age Group	Between Groups	5	216.4000	43.2800	3.8900	0.0025	12.50%	A higher F-value and a higher η^2 indicate stronger evidence of significant differences in BMI across age groups (p < 0.05).
	Within Groups	136	1512.6800	11.1200				
	Total	141	1729.0800					
BMI Across Gender	Between Groups	1	33.8122	33.8122	2.7923	0.0970	2.00%	A higher F-value and a higher η^2 indicate stronger evidence of significant differences in BMI across Gender (p < 0.05).
	Within Groups	140	1695.2628	12.1090				
	Total	141	1729.0751					
SBP across Age Groups	Between Groups	5	2886.8975	577.3795	2.5212	0.0323	8.50%	A higher F-value and a higher η^2 indicate stronger evidence of significant differences in SBP across Age Groups (p < 0.05).
	Within	136	31145.7	229.01				

	n Groups		793	31				
	Total	141	34032.6768					
DBP across Age Groups	Between Groups	5	744.0027	148.8005	0.7401	0.5947	2.60%	A higher F-value and a higher η^2 indicate stronger evidence of significant differences in DBP across Age Groups ($p < 0.05$).
	Within Groups	140	27343.7841	201.0572				
	Total	141	28087.7868					
SBP across Gender	Between Groups	1	1673.1673	1673.1673	5.9473	0.0160	4.10%	A higher F-value and a higher η^2 indicate stronger evidence of significant differences in SBP across Gender($p < 0.05$).
	Within Groups	140	39386.3793	281.3313				
	Total	141	41059.5467					
DBP across Gender	Between Groups	1	1157.0350	1157.0350	5.6923	0.0184	3.90%	A higher F-value and a higher η^2 indicate stronger evidence of significant differences in DBP across Gender($p < 0.05$).
	Within Groups	140	28456.9056	203.2636				
	Total	141	29613.9407					

4. Discussion of ANOVA Summary for BMI and Blood Pressure Across Age Groups and Gender

4.1. BMI Across Age Groups:

The ANOVA results revealed a statistically significant difference in BMI across the six age groups, with $F(5,136) = 3.89$ and a p-value of 0.0025. The effect size, represented by eta-squared ($\eta^2 = 12.5\%$), indicates a moderate practical significance, suggesting that approximately 12.5% of the total variance in BMI is attributable to differences between age groups. This finding implies that BMI meaningfully varies with age, potentially reflecting age-related changes in metabolism, lifestyle, or body composition across

different stages of life.

4.2. BMI Across Gender:

For gender, the ANOVA results indicate no statistically significant difference in BMI, with $F(1,140) = 2.79$ and a p-value of 0.097. The effect size is very small, with eta-squared ($\eta^2 = 2.0\%$), suggesting that gender accounts for only 2% of the variance in BMI. This indicates that the differences in BMI between males and females in this sample are minimal and not statistically meaningful.

4.3. Systolic Blood Pressure (SBP) Across Age Groups:

The ANOVA results indicate a significant difference in systolic blood pressure (SBP) across the six age groups, with $F(5,136) = 2.52$ and a p-value of 0.0323. The effect size, represented by eta-squared ($\eta^2 = 8.5\%$), reflects a modest effect, suggesting that age group differences account for a notable portion of the variability in SBP. This finding is consistent with established physiological trends, as SBP typically increases with age due to vascular changes such as arterial stiffening.

4.4. Diastolic Blood Pressure (DBP) Across Age Groups:

The ANOVA results show that the differences in diastolic blood pressure (DBP) across age groups were not statistically significant, with $F(5,140) = 0.74$ and a p-value of 0.5947. The effect size, measured by eta-squared ($\eta^2 = 2.6\%$), is small, indicating that age groups account for only a negligible portion of the variance in DBP. This suggests that DBP remains relatively stable across different age groups, or alternatively, that the sample size may not be large enough to detect subtle age-related differences.

4.5. SBP Across Gender:

The ANOVA results reveal a significant difference in systolic blood pressure (SBP) between genders, with $F(1,140) = 5.95$ and a p-value of 0.016. The effect size, represented by eta-squared ($\eta^2 = 4.1\%$), indicates that gender explains a small but statistically significant portion of the variance in SBP. This finding aligns with typical physiological patterns, where males generally tend to have higher SBP than females.

4.6. DBP Across Gender:

Similarly, the ANOVA results show a significant difference in diastolic blood pressure (DBP) between genders, with $F(1,140) = 5.69$ and a p-value of 0.018. The effect size, indicated by eta-squared ($\eta^2 = 3.9\%$), suggests that gender accounts for a small but statistically significant portion of the variance in DBP. This finding supports the common observation that males generally have higher DBP compared to females.

5. Conclusion:

The statistical analysis highlights the significant influence of age on both Body Mass Index (BMI) and Systolic Blood Pressure (SBP). The observed increases in BMI and SBP with advancing age likely reflect underlying physiological changes, such as metabolic shifts and increased arterial stiffness. These findings emphasize the need to consider age as a critical factor in the assessment and management of cardiovascular risk.

In contrast, Diastolic Blood Pressure (DBP) does not vary significantly across age groups, suggesting that it remains relatively stable throughout adulthood in this sample. This relative stability may indicate that DBP is less affected by age-related vascular changes compared to SBP.

Gender-based differences are also evident, with males showing significantly higher SBP and DBP values than females. Although these differences are statistically significant, the associated effect sizes are small, indicating that gender explains only a limited proportion of the variability in blood pressure. Meanwhile, BMI does not differ significantly between males and females, suggesting a similar distribution of body mass across genders in this population.

In summary, the findings underscore the importance of incorporating both age and gender into clinical evaluations of BMI and blood pressure. Tailored interventions that address the age-associated rise in BMI and

SBP, along with gender-specific approaches to blood pressure control, may contribute to better cardiovascular health outcomes.

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