

***Which metal combination works well with human
battery?***

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ABSTRACT

The human body contains enormous quantities of energy. In fact, the average adult has as much energy stored in fat as a one-ton battery. That energy fuels our everyday activities, but what if those actions could in turn run the electronic devices we rely on?

A “Human Battery” uses the human body to establish the circuit needed to produce electrical flow, wherein the strength of the current can be controlled by the resistance of body (skin) towards the electric flow. Metals are very efficient at this electrical current we have created.

This project aims at comparing the electrical flow generated by the human battery through three different metal combinations to know which metal combination can work well. Three metals namely Copper, Zinc and Lead were selected and their combinations (Copper-Lead, Copper-Zinc and Lead-Zinc) were used. The human subject was made to place his/her hands on the plates which give the multimeter (in terms of microamperes) a reading of how strong the electric current is in the subject’s body. 10 Male and Female subjects were selected in each of following age groups; 3-4, 14-15, 20-30 and above 50. The experiment was conducted at three different conditions- with dry hands, with rubbed hands and then with wet hands. The readings were plotted into a graph for each of the combination cases. The consolidated report was prepared with the calculated average readings for the comparison purposes.

The highest reading (183.2 μA) was recorded with Copper-Zinc metal combination with Wet hand condition for Females of age group 14-15 whereas the lowest reading (6.27 μA) was recorded in Lead-Zinc combination with Dry Hand condition for Females above 50.

In the case where the human's hands are wet, the reading on the current meter is higher than when the hands were not wet. The human body resists the flow of current through the skin. When wet hands are placed on the plates, the resistance to current is decreased thus increasing the flow of current and creating a higher result on the meter.

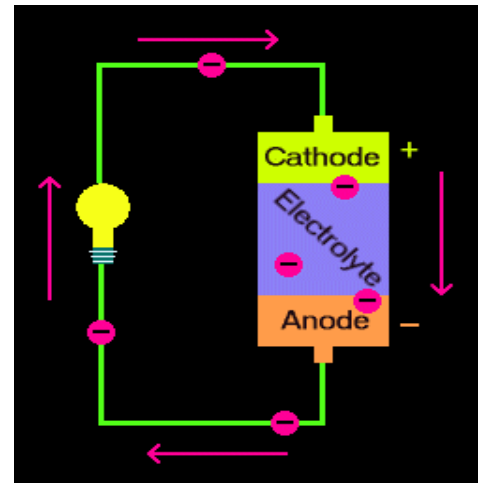
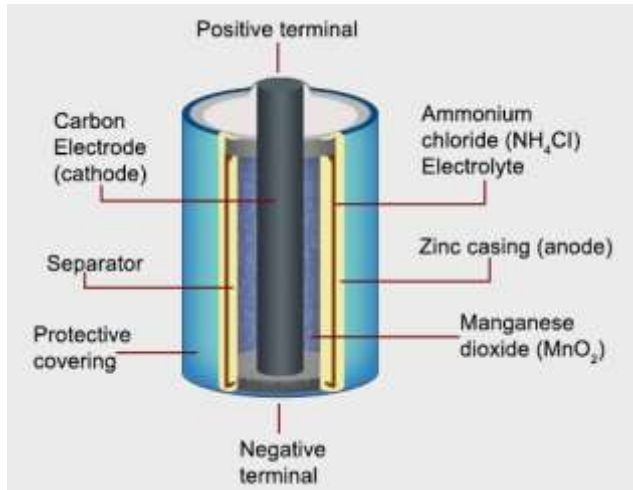
At last I found, **Copper-Zinc combination works well in all the three experimental cases for all the considered age groups and Age group 14-15 is more suitable for human battery.**



INTRODUCTION (BACKGROUND INFORMATION)

How do batteries work?

Electricity is the flow of electrons through a conductive path like a wire. This path is called a circuit. Batteries have three parts, an anode (-), a cathode (+), and the electrolyte. The cathode and anode (the positive and negative sides at either end of a traditional battery) are hooked up to an electrical circuit.



The chemical reactions in the battery cause an unstable buildup of electrons at the anode. This results in an electrical difference between the anode and the cathode. The electrons will try to rearrange themselves to get rid of this difference. But they do this in a certain way. Electrons repel each other and try to go to a place with fewer electrons.

In a battery, the only place to go is to the cathode. But, the electrolyte keeps the electrons from going straight from the anode to the cathode within the battery. When the circuit is closed (a wire connects the cathode and the anode) the electrons will be able to get to the cathode. The electrons go through the wire, powering the electrical device along the way. This is how electrical potential causes electrons to flow through the circuit. However, these electrochemical processes change the chemicals in anode and cathode to make them stop supplying electrons. So there is a limited amount of power available in a battery.

When we *recharge* a battery, we change the direction of the flow of electrons using another power source, such as solar panels. The electrochemical processes happen in reverse, and the anode and cathode are restored to their original state and can again provide full power.

One of the big problems is that batteries leak. If we put a battery on the shelf and don't use it, it will lose some of the energy stored on its own, so there has been a lot of research in how to avoid this.

Scope of human battery:

With cell phones and other portable electronic devices that we use, we often face the problem of keeping the batteries charged. How wonderful it would be if the human body could be employed to perform the act of charging the batteries for our favourite devices?



The human body generates more bioelectricity than a 120-volt battery and over 25,000 BTUs (1.000003931 BTU= 1055.06 Joules) of body heat. The average human, at rest, produces around 100 watts of power. This equates to around 2000 kcal of food energy, which is why our recommended daily intake of calories is around 2000 kcal. The bulk of this energy is required for important tasks, such as pumping our heart and flexing our muscles, but a lot of it is wasted — primarily as heat, but also through other physical inefficiencies. Almost all of this wasted energy could be captured and turned into electricity, which could then augment or completely replace our reliance on chemical batteries.

Electrical Properties of Human Body:

Human body consists of up to 60% of the water. The total amount of water in a man of average weight (70 kilograms) is approximately 40 litres. The body water is broken down into the following compartments:

1. Intracellular fluid (2/3 of body water)
2. Extracellular fluid (1/3 of body water)

Intracellular as well as extracellular fluids are electrolytes full of biochemical ions, therefore well conductive. The cell membranes are isolants. If the voltage that is not changing is applied (DC) the direct current can flow through the extracellular fluids. DC cannot pass through the cell membranes, so it cannot flow intracellularly (contrary to AC).

Tissue	Electric Properties	
	Dielectric Constant (ϵ_r)	Tissue Conductivity (σ) (S/m)
Average Bone	11.74	0.43
Fat	5.28	0.11
Muscle	52.74	1.73
Skin	38.01	1.46

Reference:https://www.google.com/url?sa=i&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwixjPSih8vmAhX2zzgGHTilArsQjhx6BAgBEAI&url=https%3A%2F%2Fwww.researchgate.net%2Ffigure%2FElectric-properties-of-specific-human-tissues-at-2440-MHz-used-within-the-constructed_tbl1_261403152&psig=AOvVaw0mR76URX5HnrRS1VZdHmBJ&ust=1577165547826999

Utilizing body heat and kinesthetic:

Movement produces kinetic energy, which can be converted into power. In the past, devices that turned human kinetic energy into electricity, such as hand-cranked radios, computers and flashlights, involved a person's full participation. The best source of energy is body heat, or thermoelectric generation. Thermoelectric generation works because our bodies are almost always a different temperature from the air outside. The obvious advantage of body heat is that there is no need to do anything to generate power. But the challenge is that we can only harvest very little energy at once. The devices which convert body heat into usable electricity are basically relying on just a few degrees of temperature difference, sometimes just a degree or less, so the devices have to be really efficient when engineered to use a small amount of heat to generate useful power.

Working of Human Battery:

Placing the hands on the metal plates causes the effect of a battery charge. The chemical reaction that allows electrons to flow from the copper to the zinc can't occur without an acidic solution, such as that found in a battery. Our hands contain a thin film of sweat that produces a chemical reaction similar to battery acid when placed on the metal plates. In case of Copper-Zinc combination, our hands take negatively charged electrons away from the copper plate and transfer them to the zinc plate, causing it to be negatively charged. The variance in charges between the plates produces an electrical current which flows through our body and displays on the meter.

STATEMENT OF THE PROBLEM

With the technology in the current scenario, every single energy produced could be made useful. Using human power as a battery may seem non-feasible, but with uniting all such mechanical energy may even power a house. But the idea is about making use of one's own energy to power themselves. Utilizing is more important than producing. It is necessary to know which metal combination will be better.

HYPOTHESIS

Copper-Zinc combination works well with human battery.

DESIGN OF STUDY

INDEPENDENT VARIABLE:

- Human Subjects

DEPENDENT VARIABLE:

- Current Flow

CONTROLLED VARIABLES:

- Metal Combination (Copper-Lead, Copper-Zinc, Zinc-Lead)

MATERIALS:

- Lead Plate (2)
- Copper Plate (2)
- Zinc Plate (2)
- Micro Ammeter (3)
- 6 Alligator Clips
- Connecting Wire
- Human volunteers

PROCEDURE:

1. Clean the metal plates before mounting.
2. Set the three metal combinations (Copper-Lead, Copper-Zinc, Zinc-Lead) on a wooden table.
3. Take three micro ammeters and connect one terminal of each ammeter to one metal and another terminal to its another metal combination
4. Now place one hand on each plate (Cu-Pb). An electric current is generated on the meter. If readings are not seen then simply reverse the connections. Note down the ammeter readings. Do the same for other two metal combinations (Cu-Zn, Zn-Pb). This will be the reading for dry hands.
5. **Rub the hands** and then place on each plate immediately. Note down the ammeter readings. Do the same for other two metal combinations (Cu-Zn, Zn-Pb).
6. **Wet the hands** with water and place on each plate. Note down the ammeter readings. Do the same for other two metal combinations (Cu-Zn, Zn-Pb).
7. **Repeat the procedure for different humans (both Male and Female under different age group 3-4, 14-15, 20-30, above 50)**
8. Compare the readings of all three metal combinations for different humans,

Setting up



METAL COMBINATIONS





3-4 male





14-15 male





20-30 male





Above 50 male





3-4 female





14-15 female





20-30 female





Above 50 female



Tabulation 1: The Effect Of 3-4 Age Group Male Human Battery On Different Metal Combination

S.No	Human Subjects	Age	Trial	Dry Hands			Rubbed Hands			Wet Hands		
				Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn
1	Tharani Tharan	4	Trial 1	38	68	53	40	91	87	43	107	37
			Trial 2	42	82	57	37	100	67	39	99	34
			Trial 3	35	56	58	43	98	68	37	90	33
			AVG	38.3333333	68.6666667	56	40	96.3333333	74	39.6666667	98.6666667	34.6666667
2	Mohamed Tharik S	4	Trial 1	25	36	22	28	54	35	34	92	45
			Trial 2	19	35	25	30	78	24	36	101	48
			Trial 3	17	35	27	25	63	39	27	104	50
			AVG	20.3333333	35.3333333	24.6666667	27.6666667	65	32.6666667	32.3333333	99	47.6666667
3	Haafiz	4	Trial 1	29	75	47	53	83	46	40	127	54
			Trial 2	39	72	41	47	77	56	37	123	47
			Trial 3	40	71	40	44	92	46	39	121	47
			AVG	36	72.6666667	42.6666667	48	84	49.3333333	38.6666667	123.666667	49.3333333
4	Ahamad Tanvir	4	Trial 1	26	70	34	30	60	39	37	117	46
			Trial 2	30	60	30	25	62	37	326	116	41
			Trial 3	33	64	23	37	76	32	34	110	46
			AVG	29.6666667	64.6666667	29	30.6666667	66	36	132.333333	114.333333	44.3333333
5	Mohamed Irfan	4	Trial 1	29	72	31	44	46	55	40	130	47
			Trial 2	29	44	25	36	84	41	38	115	44
			Trial 3	31	74	29	34	58	40	37	130	45
			AVG	29.6666667	63.3333333	28.3333333	38	62.6666667	45.3333333	38.3333333	125	45.3333333
6	Fadhil Abraç	3	Trial 1	39	64	57	48	83	63	42	128	70
			Trial 2	42	73	51	34	100	44	37	122	60
			Trial 3	42	56	52	36	108	44	30	128	70
			AVG	41	64.3333333	54.5	39.3333333	97	50.3333333	36.3333333	126	66.6666667
7	Umesh	4	Trial 1	18	353	30	32	53	34	41	117	48
			Trial 2	20	46	21	29	71	22	39	99	44
			Trial 3	20	51	22	29	62	23	40	98	43
			AVG	19.3333333	150	24.3333333	30	62	26.3333333	40	104.666667	45
8	Ahamed Umar	4	Trial 1	11	126	84	74	146	97	32	130	56
			Trial 2	12	48	68	80	153	89	34	113	50
			Trial 3	11	46	60	79	146	78	34	111	52
			AVG	32.5376344	74.0645161	39.85	40.2473118	83.1290323	49.0322581	49.3763441	113.526882	48.0645161
9	Ahamed Tawsiq	4	Trial 1	27	61	25	22	69	26	50	186	66
			Trial 2	26	60	20	24	63	34	49	159	62
			Trial 3	23	53	20	28	67	32	47	166	63
			AVG	31.9201229	72.6875576	38.2455882	38.911828	81.6894009	47.4580645	49.3155146	118.396006	49.4018433
10	Mohamed Ishan	4	Trial 1	37	82	53	53	89	56	49	145	42
			Trial 2	31	76	50	68	103	63	47	123	38
			Trial 3	31	72	45	58	95	66	46	122	37
			AVG	32.0031904	72.9936429	39.1209365	40.508354	82.7645752	48.5510339	49.1630391	119.288621	48.6017015

Tabulation 2: The Effect Of *14-15 Age Group Male* Human Battery On Different Metal Combination

S. No	Human Subjects	Age	Trial	Dry Hands			Rubbed Hands			Wet Hands		
				Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn
1	Mohamed Anifa	15	Trial 1	45	82	53	84	137	51	93	238	127
			Trial 2	37	88	49	80	126	67	83	225	120
			Trial 3	37	95	42	72	123	53	84	228	118
			AVG	39.666667	88.3333	48	78.6667	128.667	57	86.6667	230.333	121.667
2	Abdurrahmaan	14	Trial 1	50	115	76	68	162	94	78	194	113
			Trial 2	53	118	76	69	158	81	68	186	113
			Trial 3	56	105	78	61	145	91	66	179	109
			AVG	53	112.667	76.6667	66	155	88.6667	70.6667	186.333	111.667
3	Mohammed Thanish Yehya	14	Trial 1	90	194	139	98	316	155	75	266	137
			Trial 2	97	198	135	114	289	188	68	255	127
			Trial 3	80	206	110	107	269	177	66	261	124
			AVG	89	199.333	128	106.333	291.333	173.333	69.6667	260.667	129.333
4	Mohamed Mustak	14	Trial 1	69	213	125	125	273	154	87	248	118
			Trial 2	78	196	121	112	256	138	2	228	109
			Trial 3	80	203	126	110	231	157	81	19	105
			AVG	75.666667	204	124	115.667	253.333	149.667	56.6667	165	110.667
5	Mohamed Fasith	15	Trial 1	39	67	41	41	105	61	34	89	70
			Trial 2	36	78	37	43	106	67	31	91	56
			Trial 3	36	72	38	46	116	70	26	86	49
			AVG	37	72.3333	38.6667	43.3333	109	66	30.3333	88.6667	58.3333
6	Mohamed Uvaish	15	Trial 1	42	78	58	68	146	95	47	119	58
			Trial 2	34	75	53	82	116	93	44	112	56
			Trial 3	34	75	48	70	161	97	44	114	56
			AVG	36.666667	76	53	73.3333	141	95	45	115	56.6667
7	Abdul Mazid	14	Trial 1	62	133	96	70	125	80	33	69	34
			Trial 2	68	143	89	64	129	82	35	64	30
			Trial 3	61	153	80	56	125	84	34	63	30
			AVG	63.666667	143	88.3333	63.3333	126.333	82	34	65.3333	31.3333
8	Salman Farish	14	Trial 1	25	63	52	57	149	68	49	113	59
			Trial 2	26	61	42	59	136	68	43	108	57
			Trial 3	28	56	37	68	137	68	40	100	50
			AVG	26.3333333	60	43.6667	61.3333	140.667	68	44	107	55.3333
9	Syed Mohamed	14	Trial 1	37	170	119	104	190	118	74	231	132
			Trial 2	43	150	108	90	155	129	74	231	131
			Trial 3	47	140	101	87	168	139	74	225	118
			AVG	42.3333333	153.333	109.333	93.6667	171	128.667	74	229	127
10	Ameer Khan	14	Trial 1	70	168	102	74	183	139	100	280	151
			Trial 2	67	162	103	86	183	117	102	265	148
			Trial 3	68	156	98	88	189	115	100	261	141
			AVG	68.3333333	162	101	82.6667	185	123.667	100.667	268.667	146.667

Tabulation 3: The Effect Of *20-30 Age Group Male* Human Battery On Different Metal Combination

S. No	Human Subjects	Age	Trial	Dry Hands			Rubbed Hands			Wet Hands		
				Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn
1	Prince	25	Trial 1	67	105	62	63	123	73	66	150	71
			Trial 2	62	112	55	61	121	75	60	143	65
			Trial 3	60	103	53	63	118	78	57	135	62
			AVG	63	106.667	56.6667	62.3333	120.667	75.3333	61	142.667	66
2	Thirukumarasen	27	Trial 1	29	49	23	57	90	52	70	178	95
			Trial 2	25	53	23	56	96	55	66	175	89
			Trial 3	27	52	27	58	103	59	64	168	83
			AVG	27	51.3333	24.3333	57	96.3333	55.3333	66.6667	173.667	89
3	Ajees	19	Trial 1	9	26	11	10	28	14	39	93	43
			Trial 2	9	23	11	11	29	13	36	94	42
			Trial 3	9	26	11	11	32	14	36	98	41
			AVG	9	25	11	10.6667	29.6667	13.6667	37	95	42
4	Imraan	21	Trial 1	18	46	20	19	56	26	45	119	54
			Trial 2	16	44	19	23	64	25	46	116	46
			Trial 3	17	36	20	25	69	23	48	113	46
			AVG	17	42	19.6667	22.3333	63	24.6667	46.3333	116	48.6667
5	Sheik Abdullah Imam	27	Trial 1	60	88	36	59	103	49	55	167	84
			Trial 2	54	69	28	65	111	56	49	162	71
			Trial 3	44	67	26	53	110	57	58	163	77
			AVG	52.6667	74.6667	30	59	108	54	54	164	77.3333
6	Asik Ibrahim	27	Trial 1	69	172	52	63	119	79	67	161	87
			Trial 2	41	181	54	68	122	82	65	144	85
			Trial 3	54	190	75	71	134	82	60	134	89
			AVG	54.6667	181	60.3333	67.3333	125	81	64	146.333	87
7	Ismail Abu Arish	24	Trial 1	37	70	45	59	120	69	58	175	71
			Trial 2	42	60	35	65	116	67	47	167	65
			Trial 3	53	62	50	68	119	60	47	160	62
			AVG	44	64	43.3333	64	118.333	65.3333	50.6667	167.333	66
8	Faisel Ahamed	24	Trial 1	45	100	74	63	117	79	84	156	97
			Trial 2	35	99	70	59	126	67	80	147	95
			Trial 3	43	96	71	61	119	60	79	146	91
			AVG	41	98.3333	71.6667	61	120.667	68.6667	81	149.667	94.3333
9	Jasim	23	Trial 1	40	58	34	59	108	62	59	171	95
			Trial 2	42	57	32	69	105	53	60	178	90
			Trial 3	37	50	34	68	102	53	53	175	89
			AVG	39.6667	55	33.3333	65.3333	105	56	57.3333	174.667	91.3333
10	Ajith	23	Trial 1	17	29	13	25	37	18	64	175	85
			Trial 2	16	27	12	22	40	16	58	171	82
			Trial 3	15	28	12	20	37	16	60	161	79
			AVG	16	28	12.3333	22.3333	38	16.6667	60.6667	169	82

Tabulation 4: The Effect Of *Above 50 Age Group Male* Human Battery On Different Metal Combination

S. No	Human Subjects	Age	Trial	Dry Hands			Rubbed Hands			Wet Hands		
				Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn
1	Sevagan	64	Trial 1	25	31	17	24	35	20	75	166	70
			Trial 2	24	30	18	24	35	18	64	167	81
			Trial 3	25	28	16	23	35	18	57	176	79
			AVG	24.6666667	29.6667	17	23.6667	35	18.6667	65.3333	169.667	76.6667
2	S.Jainulavudeen	66	Trial 1	8	55	5	7	41	5	33	106	48
			Trial 2	9	43	3	9	38	4	34	107	55
			Trial 3	7	41	5	8	29	6	33	105	50
			AVG	8	46.3333	4.33333	8	36	5	33.3333	106	51
3	N. Shajahan	58	Trial 1	11	29	8	15	28	16	14	25	29
			Trial 2	12	29	5	11	26	13	12	71	31
			Trial 3	11	25	6	12	24	11	27	77	29
			AVG	11.3333333	27.6667	6.33333	12.6667	26	13.3333	17.6667	57.6667	29.6667
4	Sheik Dawood	60	Trial 1	11	27	8	21	41	15	34	85	30
			Trial 2	11	22	9	21	41	15	40	88	28
			Trial 3	11	20	9	24	35	12	36	88	29
			AVG	11	23	8.66667	22	39	14	36.6667	87	29
5	Asath Ali	56	Trial 1	7	13	8	12	17	5	54	99	54
			Trial 2	6	14	7	15	15	5	57	101	51
			Trial 3	6	12	5	15	16	5	60	99	51
			AVG	6.33333333	13	6.66667	14	16	5	57	99.6667	52
6	Abdul Kafaar	65	Trial 1	13	31	111	18	49	14	67	124	59
			Trial 2	12	29	9	17	38	12	57	116	53
			Trial 3	11	28	10	20	38	17	50	114	46
			AVG	12	29.3333	43.3333	18.3333	41.6667	14.3333	58	118	52.6667
7	Abdul Jabaar	64	Trial 1	6	16	5	12	18	12	45	130	56
			Trial 2	5	12	4	12	16	8	42	112	45
			Trial 3	5	11	5	11	17	7	44	109	52
			AVG	5.33333333	13	4.66667	11.6667	17	9	43.6667	117	51
8	Ibrahim	50	Trial 1	41	57	27	62	75	35	62	147	71
			Trial 2	43	55	23	54	77	34	59	136	65
			Trial 3	40	54	23	51	75	34	53	127	61
			AVG	41.3333333	55.3333	24.3333	55.6667	75.6667	34.3333	58	136.667	65.6667
9	Maayandi	54	Trial 1	10	20	5	16	25	10	67	144	58
			Trial 2	10	15	45	16	25	10	60	140	53
			Trial 3	10	19	4	17	25	10	57	137	53
			AVG	10	18	18	16.3333	25	10	61.3333	140.333	54.6667
10	Boomiraj	58	Trial 1	8	16	8	14	29	14	47	122	61
			Trial 2	7	16	8	14	30	14	45	115	50
			Trial 3	7	17	7	14	30	16	42	111	49
			AVG	7.33333333	16.3333	7.66667	14	29.6667	14.6667	44.6667	116	53.3333

Tabulation 5: The Effect Of *3-4 Age Group Female* Human Battery On Different Metal Combination

S. No	Human Subjects	Age	Trial	Dry Hands			Rubbed Hands			Wet Hands		
				Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn
1	Abiya	4	Trial 1	60	130	60	80	116	85	59	169	113
			Trial 2	60	130	79	75	113	87	104	153	101
			Trial 3	70	123	71	63	190	65	50	148	102
			AVG	63.3333333	127.667	70	72.6667	139.667	79	71	156.667	105.333
2	Athifa.B	4	Trial 1	36	56	84	57	42	67	44	159	84
			Trial 2	40	51	54	54	55	66	44	151	94
			Trial 3	44	47	54	66	52	59	42	145	97
			AVG	40	51.3333	64	59	49.6667	64	43.3333	151.667	91.6667
3	M. Aysha Shamiha	4	Trial 1	45	103	72	48	107	69	65	205	111
			Trial 2	39	96	72	42	114	67	54	187	113
			Trial 3	43	107	62	54	132	65	42	153	117
			AVG	42.3333333	102	68.6667	48	117.667	67	53.6667	181.667	113.667
4	S.Musfira Begam	4	Trial 1	50	209	91	75	203	115	35	139	92
			Trial 2	58	190	128	69	190	95	26	126	94
			Trial 3	63	173	112	75	175	105	30	132	88
			AVG	57	190.667	110.333	73	189.333	105	30.3333	132.333	91.3333
5	Ashfiya	4	Trial 1	41	101	54	47	95	59	24	65	99
			Trial 2	39	104	61	41	86	46	21	61	85
			Trial 3	42	81	57	45	113	56	21	60	76
			AVG	40.6666667	95.3333	57.3333	44.3333	98	53.6667	22	62	86.6667
6	S.Shifana Sherin	4	Trial 1	56	75	38	48	81	36	31	80	35
			Trial 2	49	55	36	44	94	26	28	79	36
			Trial 3	46	88	32	40	81	26	26	74	37
			AVG	50.3333333	72.6667	35.3333	44	85.3333	29.3333	28.3333	77.6667	36
7	M. Asra	4	Trial 1	36	90	32	62	129	36	45	80	28
			Trial 2	38	76	22	63	112	49	39	70	26
			Trial 3	32	96	19	51	72	47	50	53	25
			AVG	35.3333333	87.3333	24.3333	58.6667	104.333	44	44.6667	67.6667	26.3333
8	P. Yafia	4	Trial 1	72	160	83	79	144	802	61	192	79
			Trial 2	65	129	60	56	151	91	58	192	83
			Trial 3	63	144	66	68	152	73	58	175	88
			AVG	66.6666667	144.333	69.6667	67.6667	149	322	59	186.333	83.3333
9	P. Umera	4	Trial 1	35	76	47	35	136	51	42	80	35
			Trial 2	51	102	35	46	102	43	39	76	34
			Trial 3	28	94	46	40	110	46	37	71	31
			AVG	38	90.6667	42.6667	40.3333	116	46.6667	39.3333	75.6667	33.3333
10	Apsana	4	Trial 1	36	60	42	37	63	39	48	126	45
			Trial 2	25	62	49	27	68	41	42	112	42
			Trial 3	20	55	47	26	55	29	40	101	39
			AVG	27	59	46	30	62	36.3333	43.3333	113	42

Tabulation 6: The Effect Of *14-15 Age Group Female* Human Battery On Different Metal Combination

S. No	Human Subjects	Age	Trial	Dry Hands			Rubbed Hands			Wet Hands		
				Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn
1	Aseena Fathima	14	Trial 1	41	103	70	51	107	58	64	203	119
			Trial 2	37	106	67	51	92	55	64	199	116
			Trial 3	38	102	63	51	104	62	59	188	108
			AVG	38.6666667	103.667	66.6667	51	101	58.3333	62.3333	196.667	114.333
2	Sabira Banu	14	Trial 1	16	63	38	24	91	53	49	131	80
			Trial 2	19	58	42	32	100	51	43	116	76
			Trial 3	22	54	42	27	96	48	40	116	78
			AVG	19	58.3333	40.6667	27.6667	95.6667	50.6667	44	121	78
3	Tasleema	14	Trial 1	105	157	32	88	176	92	79	214	109
			Trial 2	88	167	86	84	169	82	78	212	129
			Trial 3	77	156	87	79	163	86	76	208	127
			AVG	90	160	68.3333	83.6667	169.333	86.6667	77.6667	211.333	121.667
4	Kiflath Fathima	14	Trial 1	46	100	55	43	115	62	58	164	86
			Trial 2	41	79	49	41	115	62	54	189	86
			Trial 3	37	84	46	42	117	65	53	178	86
			AVG	41.3333333	87.6667	50	42	115.667	63	55	177	86
5	Rafitha Rakshana	14	Trial 1	59	155	71	52	127	68	66	207	104
			Trial 2	61	140	76	49	132	76	60	205	98
			Trial 3	57	142	78	49	137	66	61	200	100
			AVG	59	145.667	75	50	132	70	62.3333	204	100.667
6	Shifa Fathima	14	Trial 1	45	101	57	46	131	89	131	271	108
			Trial 2	52	106	49	51	141	86	110	252	103
			Trial 3	50	107	49	60	145	77	105	227	96
			AVG	49	104.667	51.6667	52.3333	139	84	115.333	250	102.333
7	Asina Banu	14	Trial 1	56	96	61	70	117	72	52	127	64
			Trial 2	49	98	57	66	138	69	63	120	72
			Trial 3	46	85	58	70	124	66	58	112	68
			AVG	50.3333333	93	58.6667	68.6667	126.333	69	57.6667	119.667	68
8	Seerin Almas	14	Trial 1	50	104	41	69	164	78	73	207	74
			Trial 2	54	98	42	71	161	95	80	171	70
			Trial 3	51	96	340	71	161	96	75	194	69
			AVG	51.6666667	99.3333	141	70.3333	162	89.6667	76	190.667	71
9	Jamur Nisha	14	Trial 1	25	53	30	33	144	81	83	117	60
			Trial 2	22	53	28	51	132	94	65	116	58
			Trial 3	25	49	27	64	129	90	73	119	55
			AVG	24	51.6667	28.3333	49.3333	135	88.3333	73.6667	117.333	57.6667
10	Shirin Farhana	14	Trial 1	75	174	88	67	210	109	73	242	103
			Trial 2	75	163	86	74	166	113	67	241	99
			Trial 3	67	157	88	75	175	117	66	230	93
			AVG	72.3333333	164.667	87.3333	72	183.667	113	68.6667	237.667	98.3333

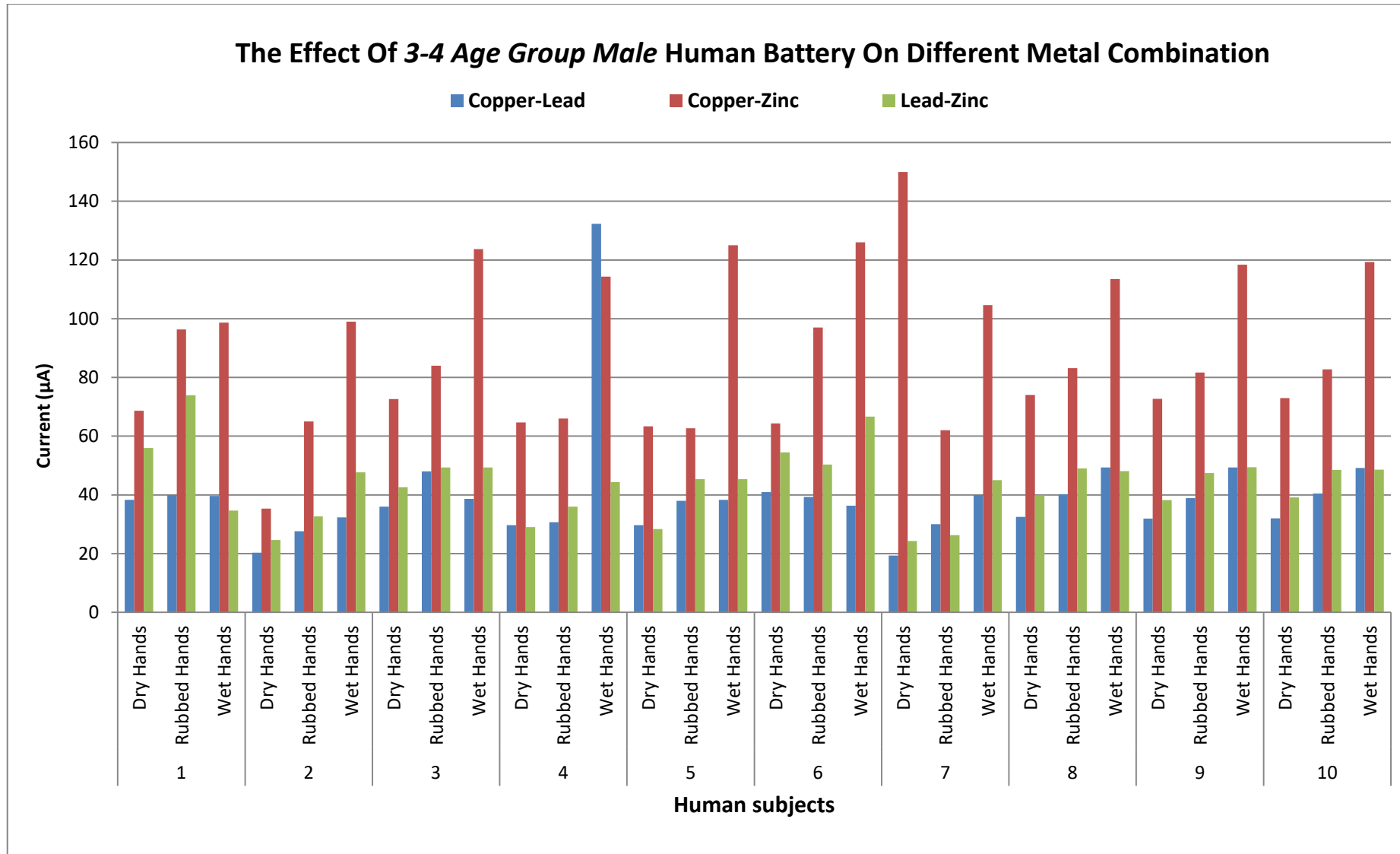
Tabulation 7: The Effect Of *20-30 Age Group Female* Human Battery On Different Metal Combination

S. No	Human Subjects	Age	Trial	Dry Hands			Rubbed Hands			Wet Hands		
				Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn
1	Rubiya Begam	21	Trial 1	35	112	49	85	171	66	52	102	56
			Trial 2	37	93	49	82	132	71	45	97	54
			Trial 3	49	78	47	70	119	62	38	101	53
			AVG	40.3333333	94.3333	48.3333	79	140.667	66.3333	45	100	54.3333
2	Shahira Banu	21	Trial 1	114	188	135	134	277	142	88	218	131
			Trial 2	116	191	125	119	269	153	77	220	132
			Trial 3	101	207	115	112	247	155	72	217	129
			AVG	110.333333	195.333	125	121.667	264.333	150	79	218.333	130.667
3	Mispha Nisha	21	Trial 1	83	90	67	105	174	112	77	153	89
			Trial 2	76	93	62	92	176	127	61	148	88
			Trial 3	64	91	63	98	155	152	59	146	87
			AVG	74.3333333	91.3333	64	98.3333	168.333	130.333	65.6667	149	88
4	Karthigai Selvi	25	Trial 1	8	11	3	8	10	6	57	202	111
			Trial 2	9	9	2	8	10	4	56	197	113
			Trial 3	8	8	2	8	11	5	57	193	108
			AVG	8.33333333	9.33333	2.33333	8	10.3333	5	56.6667	197.333	110.667
5	Aiswarya Lakshmi	23	Trial 1	14	50	1	25	41	42	38	48	18
			Trial 2	10	29	9	28	60	40	25	38	15
			Trial 3	8	21	6	25	53	475	21	37	15.6667
			AVG	10.6666667	33.3333	5.33333	26	51.3333	185.667	28	41	16.5
6	Raaviyath Basariya	30	Trial 1	34	26	16	32	28	22	69	130	61
			Trial 2	32	24	14	27	30	16	63	120	51
			Trial 3	27	24	11	23	30	14	55	112	46
			AVG	31	24.6667	13.6667	27.3333	29.3333	17.3333	62.3333	120.667	52.6667
7	Sundaravalli	24	Trial 1	31	52	26	56	97	67	52	140	75
			Trial 2	22	51	27	49	116	59	48	132	69
			Trial 3	23	49	30	45	115	58	47	128	64
			AVG	25.3333333	50.6667	27.6667	50	109.333	61.3333	49	133.333	69.3333
8	Nazia Fathima	27	Trial 1	51	64	37	76	108	55	69	183	88
			Trial 2	49	70	36	63	111	62	66	163	79
			Trial 3	23	49	34	57	100	60	60	161	77
			AVG	41	61	35.6667	65.3333	106.333	59	65	169	81.3333
9	Sithick Sunaitha	29	Trial 1	29	44	26	23	57	26	81	188	87
			Trial 2	29	48	25	23	59	25	73	174	81
			Trial 3	28	51	24	28	56	25	67	172	79
			AVG	28.6666667	47.6667	25	24.6667	57.3333	25.3333	73.6667	178	82.3333
10	Murshitha Shirin	24	Trial 1	41	30	15	84	129	34	79	178	85
			Trial 2	41	39	14	87	120	38	76	175	79
			Trial 3	46	41	70	69	115	33	76	170	79
			AVG	42.6666667	36.6667	33	80	121.333	35	77	174.333	81

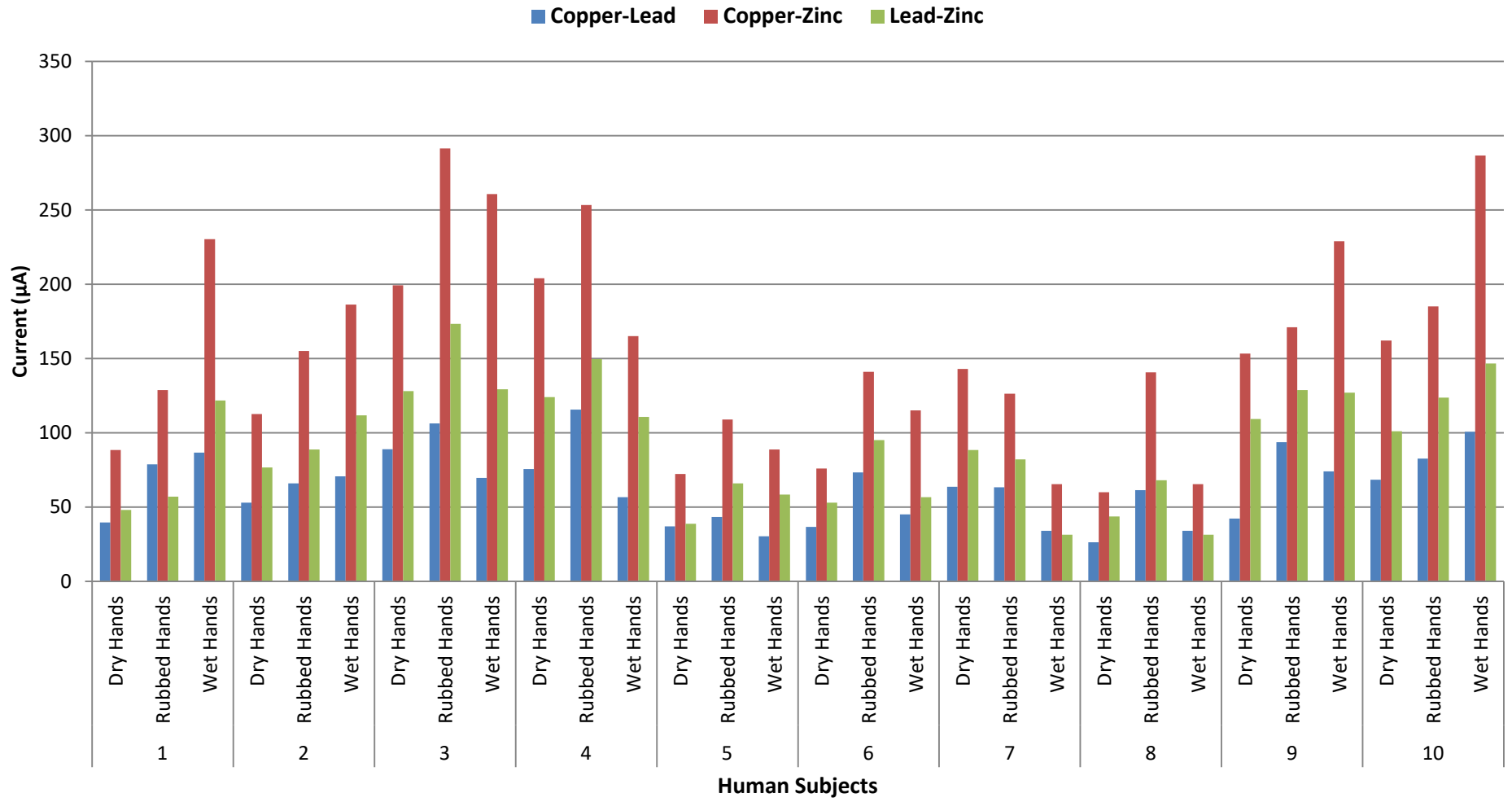
Tabulation 8: The Effect Of *Above 50Age Group Female* Human Battery On Different Metal Combination

S. No	Human subjects	Age	Trial	Dry Hands			Rubbed Hands			Wet Hands		
				Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn	Cu-Pb	Cu-Zn	Pb-Zn
1	J. Noor Jahaan	55	Trial 1	38	36	25	62	40	20	63	134	55
			Trial 2	40	41	25	54	44	25	54	139	60
			Trial 3	40	35	21	38	50	23	47	130	60
			AVG	39.3333333	37.3333	23.6667	51.3333	44.6667	22.6667	54.6667	134.333	58.3333
2	S. Sariba Begam	58	Trial 1	7	8	4	11	11	8	20	48	23
			Trial 2	7	8	3	7	10	7	19	50	28
			Trial 3	8	8	3	7	9	58	18	47	26
			AVG	7.33333333	8	3.33333	8.33333	10	24.3333	19	48.3333	25.6667
3	Rasool Beevi	62	Trial 1	5	10	1	3	5	1	19	45	25
			Trial 2	5	9	1	3	5	2	20	42	18
			Trial 3	4	8	0	3	6	2	20	42	18
			AVG	4.66666667	9	0.66667	3	5.33333	1.66667	19.6667	43	20.3333
4	Sabira Begum	50	Trial 1	6	5	4	8	24	6	29	89	30
			Trial 2	5	5	4	8	29	5	26	78	26
			Trial 3	4	5	3	5	14	6	26	70	24
			AVG	5	5	3.66667	7	22.3333	5.66667	27	79	26.6667
5	Saibu Nisha	60	Trial 1	1	1	0	1	1	1	9	25	11
			Trial 2	1	1	1	1	1	0	9	22	11
			Trial 3	1	1	0	1	1	0	11	21	11
			AVG	1	1	0.33333	1	1	0.33333	9.66667	22.6667	11
6	Baseera Begum	54	Trial 1	11	26	12	19	40	28	30	41	25
			Trial 2	9	26	10	17	47	14	30	40	21
			Trial 3	10	29	9	16	38	18	27	38	19
			AVG	10	27	10.3333	17.3333	41.6667	20	29	39.6667	21.6667
7	Firthous	53	Trial 1	2	9	6	6	15	18	58	111	38
			Trial 2	2	7	5	10	17	17	53	94	33
			Trial 3	2	5	4	13	19	12	49	94	36
			AVG	2	7	5	9.66667	17	15.6667	53.3333	99.6667	35.6667
8	Najuma Beevi	72	Trial 1	21	19	11	21	30	10	35	79	24
			Trial 2	19	24	9	19	25	9	31	88	18
			Trial 3	18	23	11	29	24	7	35	82	26
			AVG	19.3333333	22	10.3333	23	26.3333	8.66667	33.6667	83	22.6667
9	A. Noor Jahan	57	Trial 1	6	11	3	4	7	4	30	61	40
			Trial 2	5	9	2	3	6	3	30	60	37
			Trial 3	4	8	2	3	7	3	29	57	34
			AVG	5	9.33333	2.33333	3.33333	6.66667	3.33333	29.6667	59.3333	37
10	Asha	50	Trial 1	7	14	3	7	11	3	12	57	25
			Trial 2	4	12	3	7	9	3	13	56	26
			Trial 3	5	10	3	5	9	3	12	53	25
			AVG	5.33333333	12	3	6.33333	9.66667	3	12.3333	55.3333	25.3333

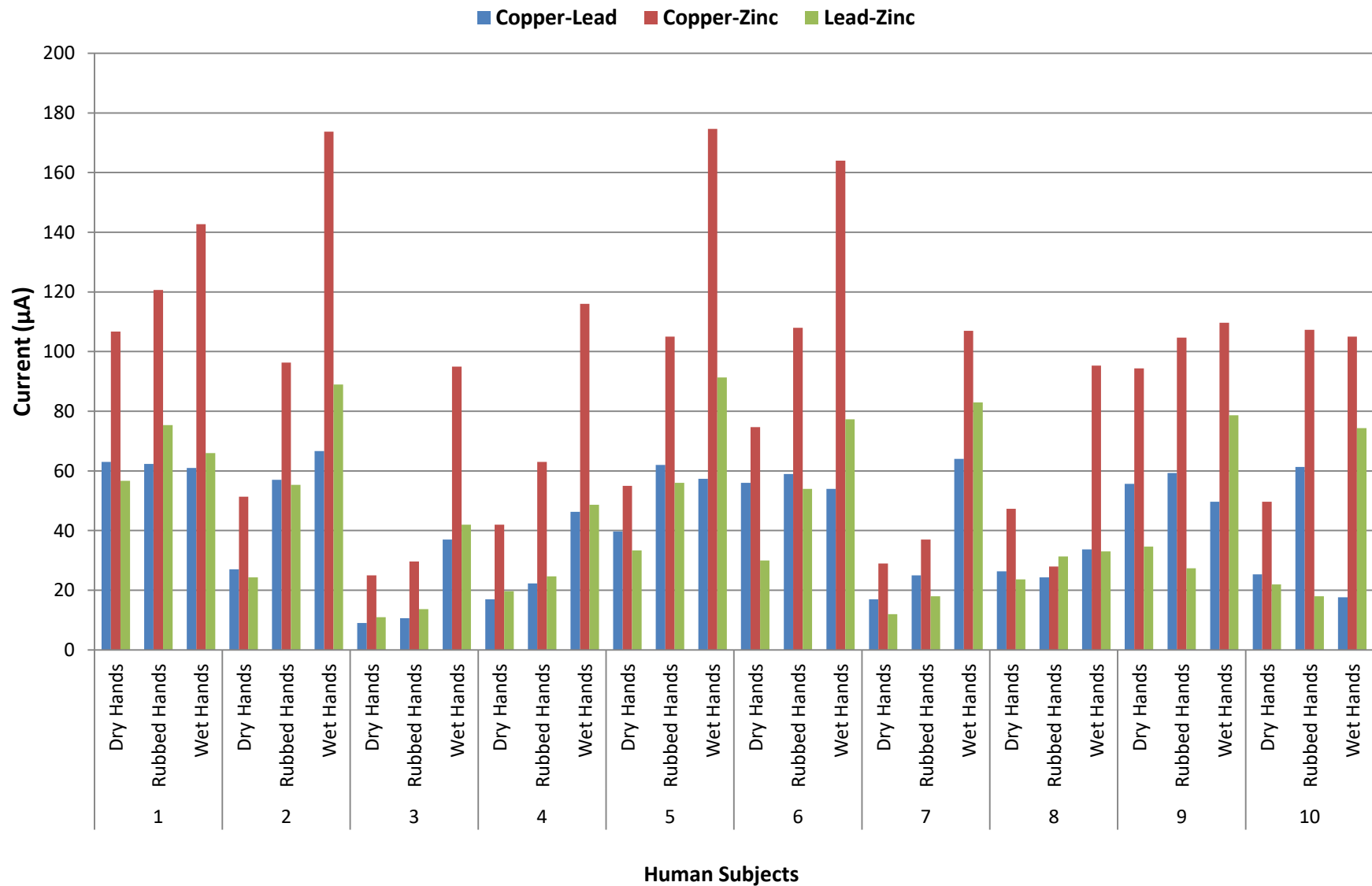
Graphical Representation



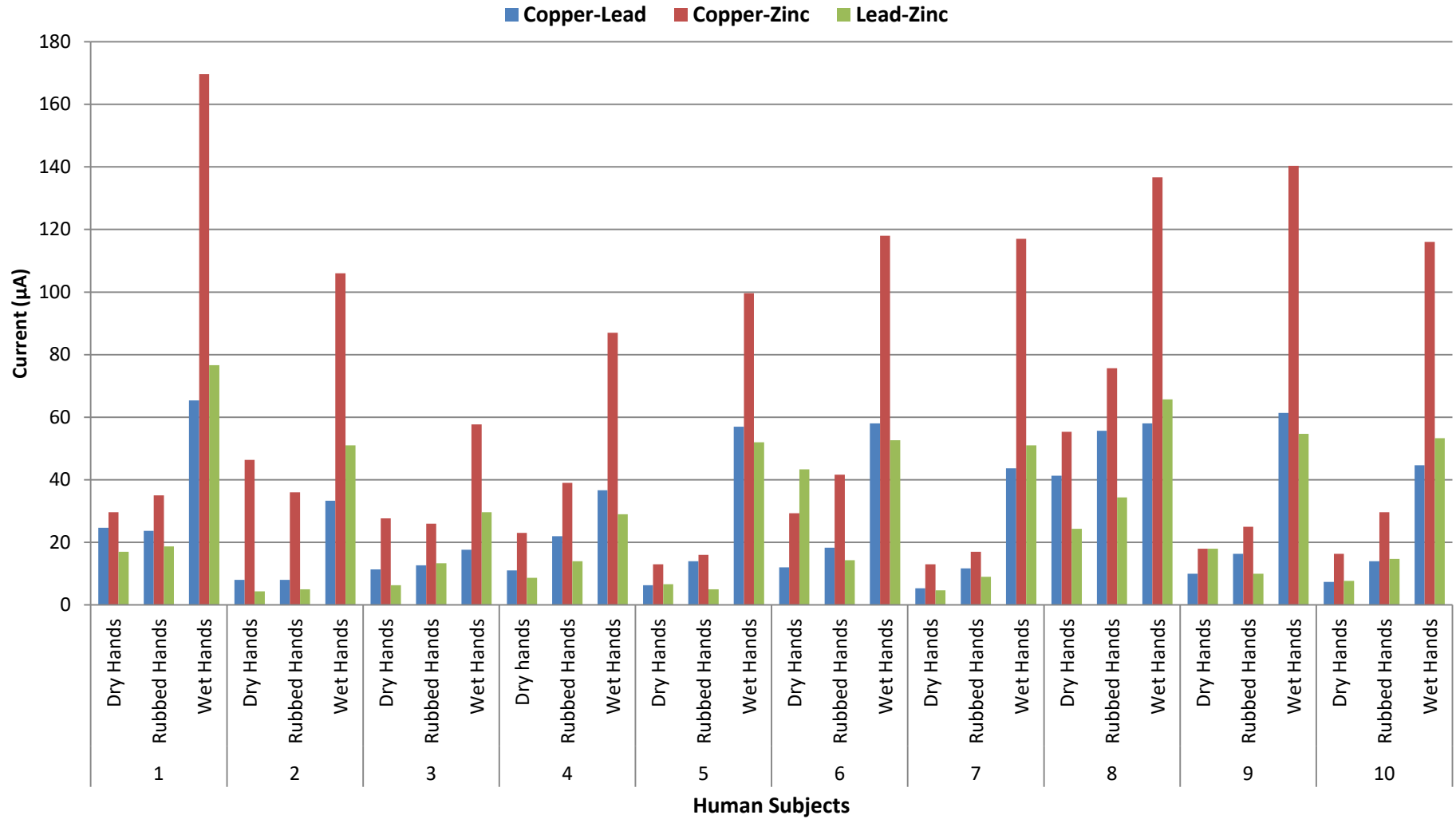
The Effect Of 14-15 Age Group Male Human Battery On Different Metal Combination



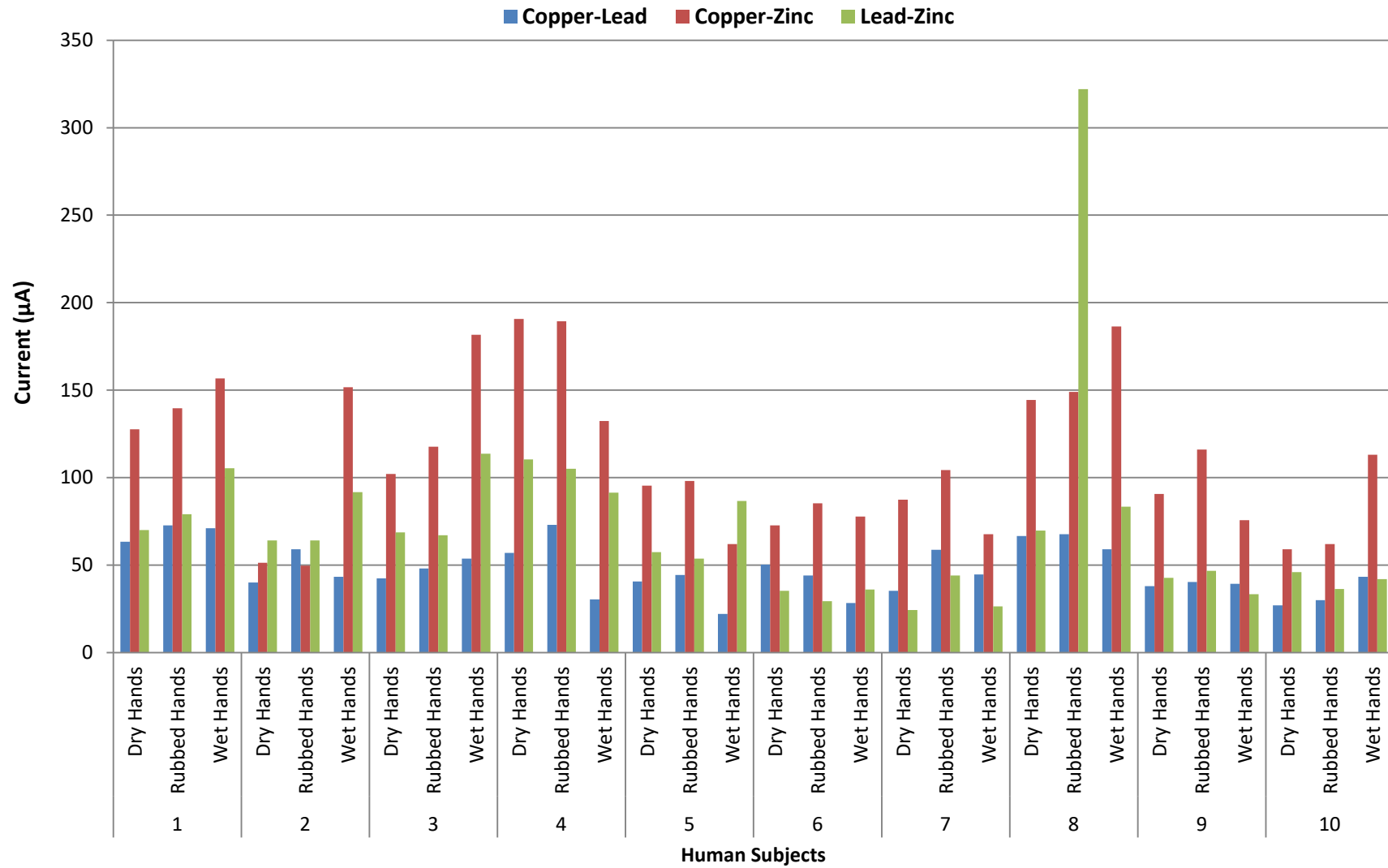
The Effect Of 20-30 Age Group Male Human Battery On Different Metal Combination



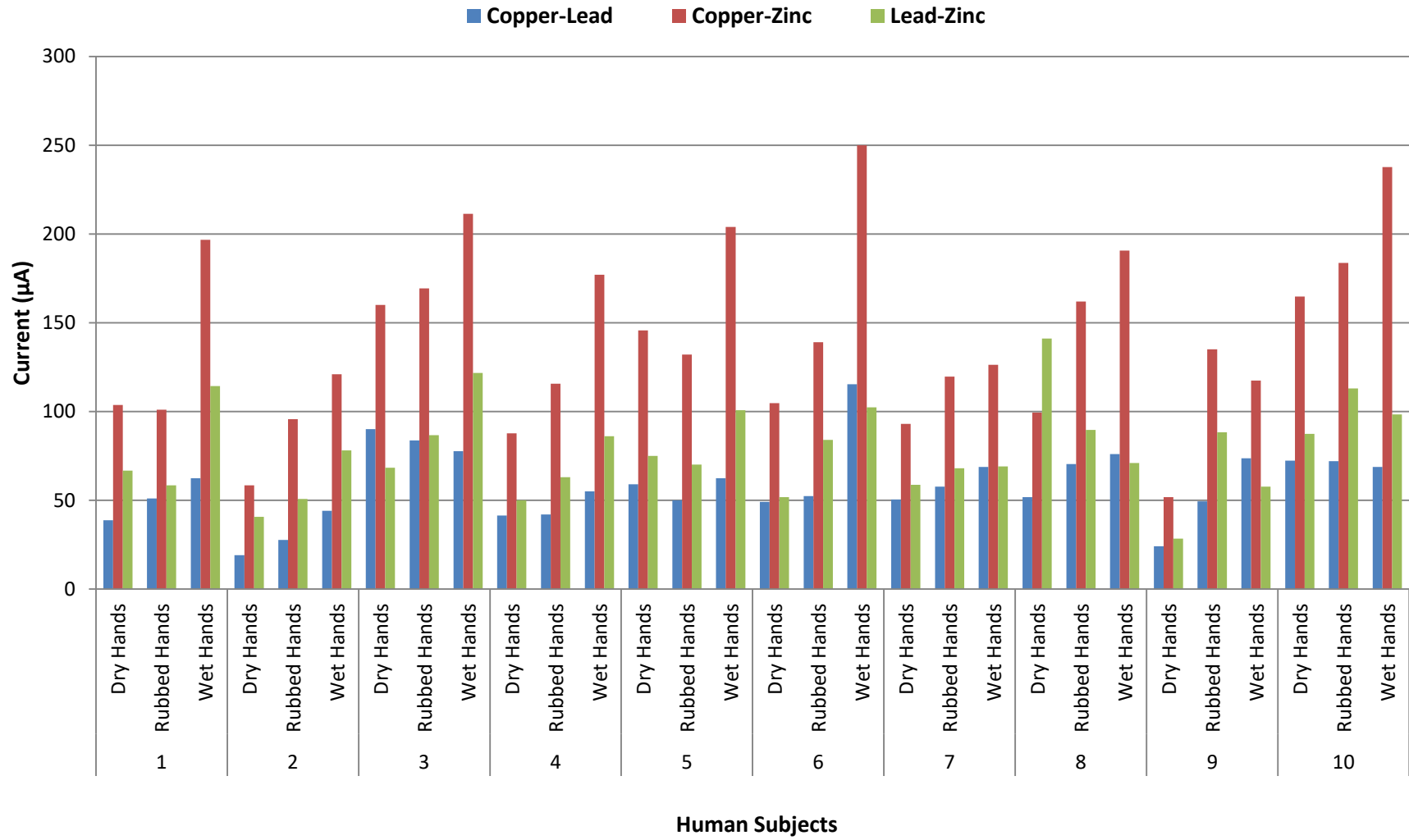
The Effect Of above 50 Age Group Male Human Battery On Different Metal Combination



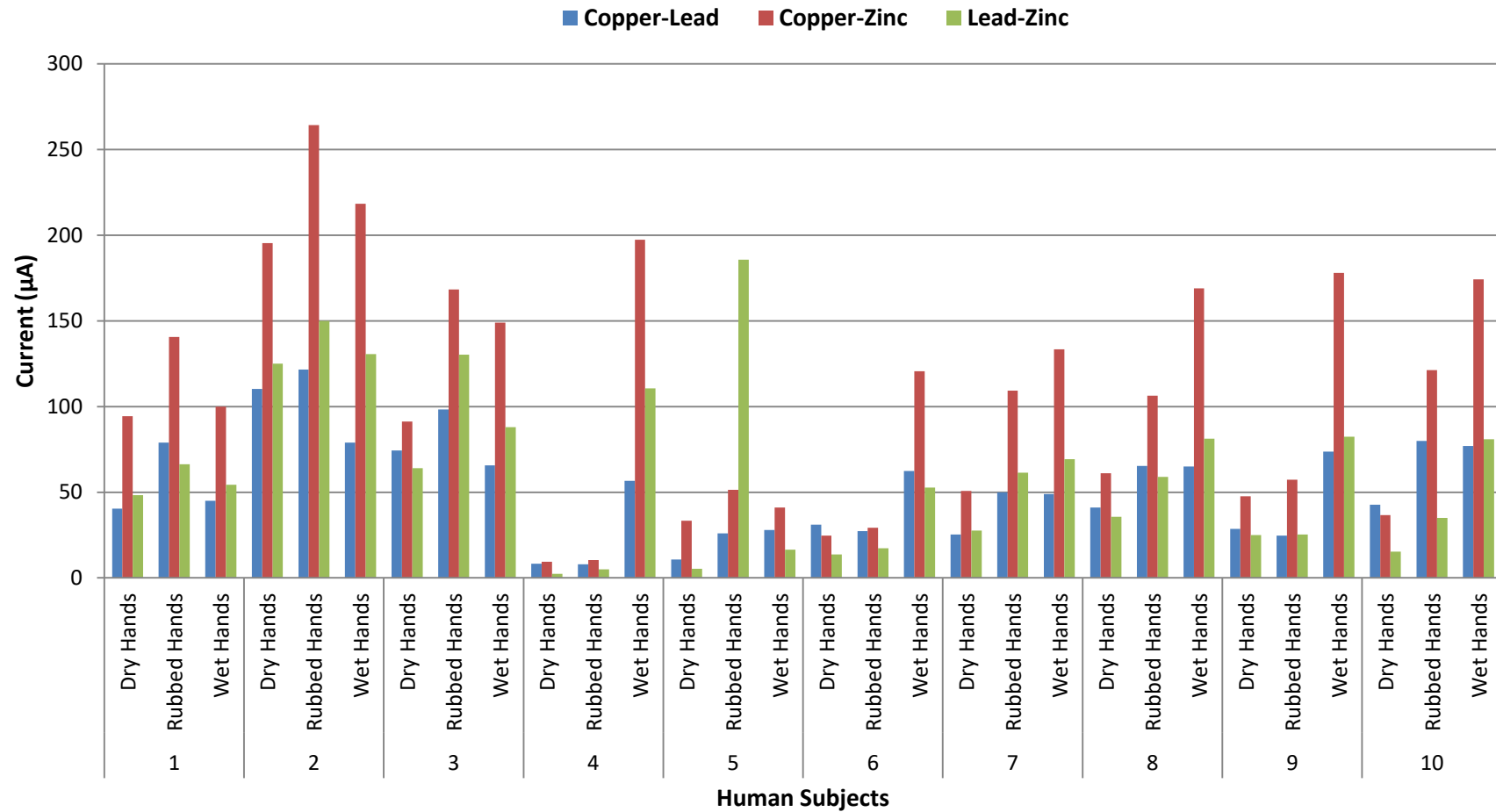
The Effect Of 3-4 Group Female Human Battery On Different Metal Combination



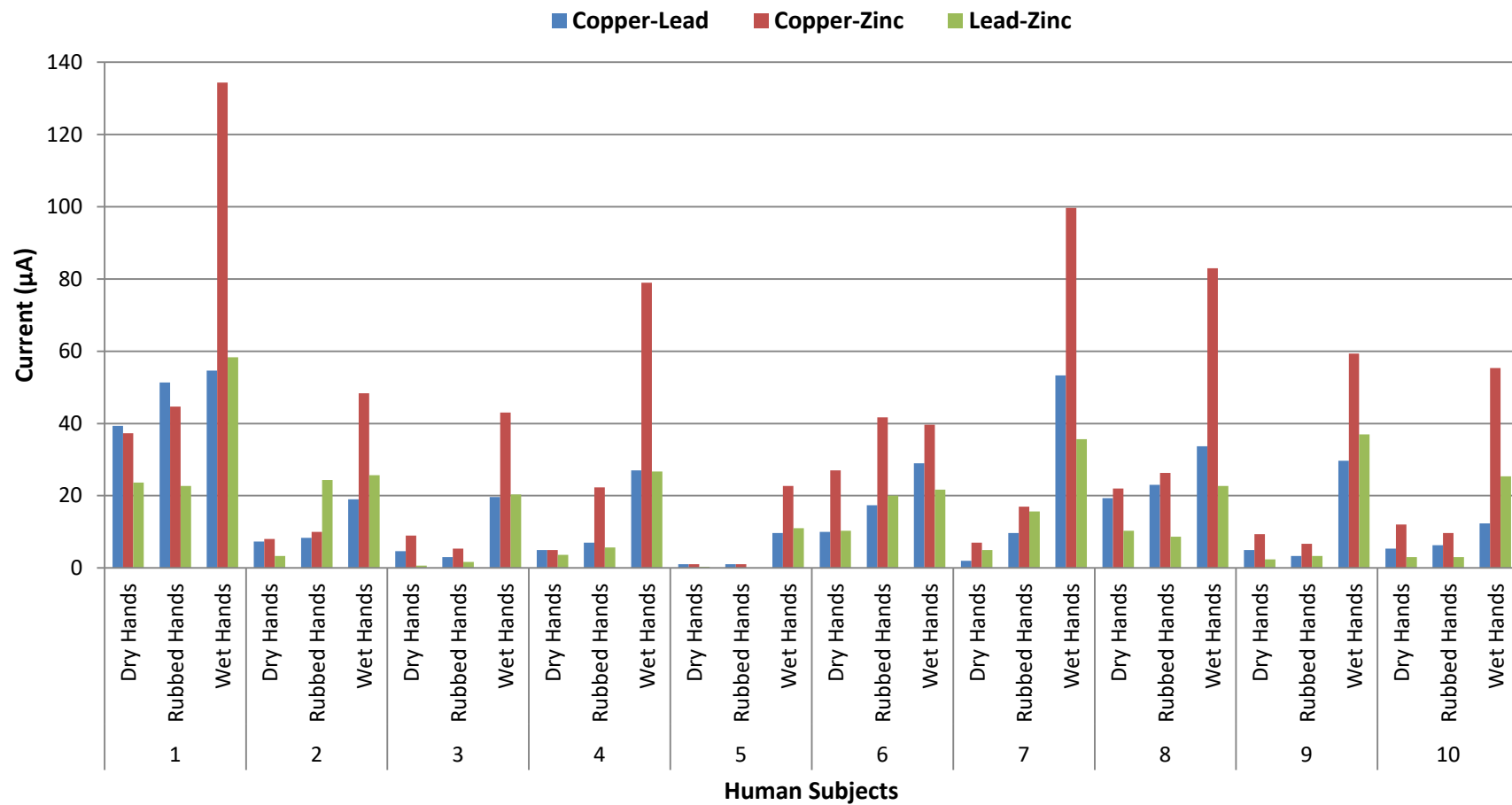
The Effect Of 14-15 Age Group Female Human Battery On Different Metal Combination



The Effect Of 20-30 Age Group Female Human Battery On Different Metal Combination



The Effect Of Above 50 Age Group Female Human Battery On Different Metal Combination



RESULTS AND DISCUSSION

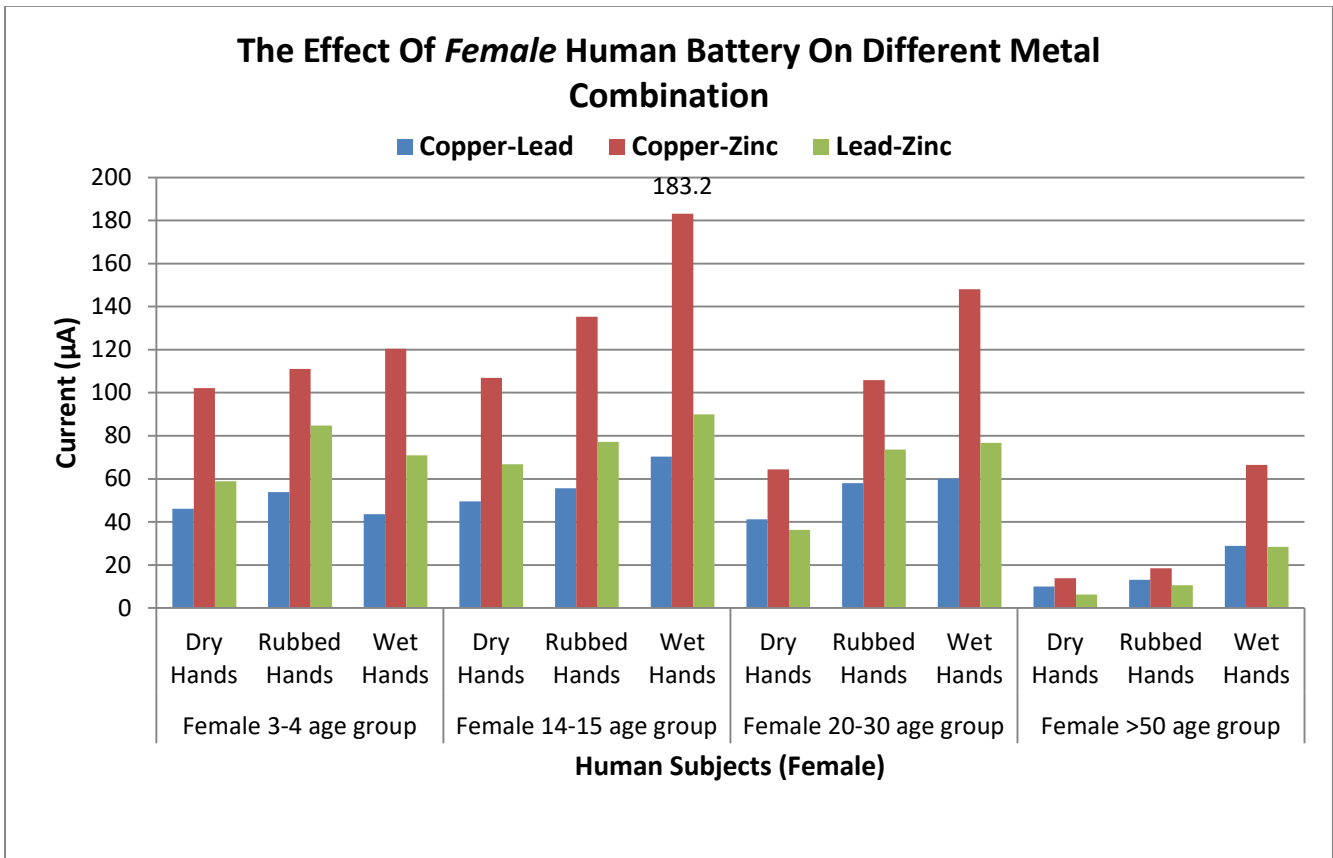
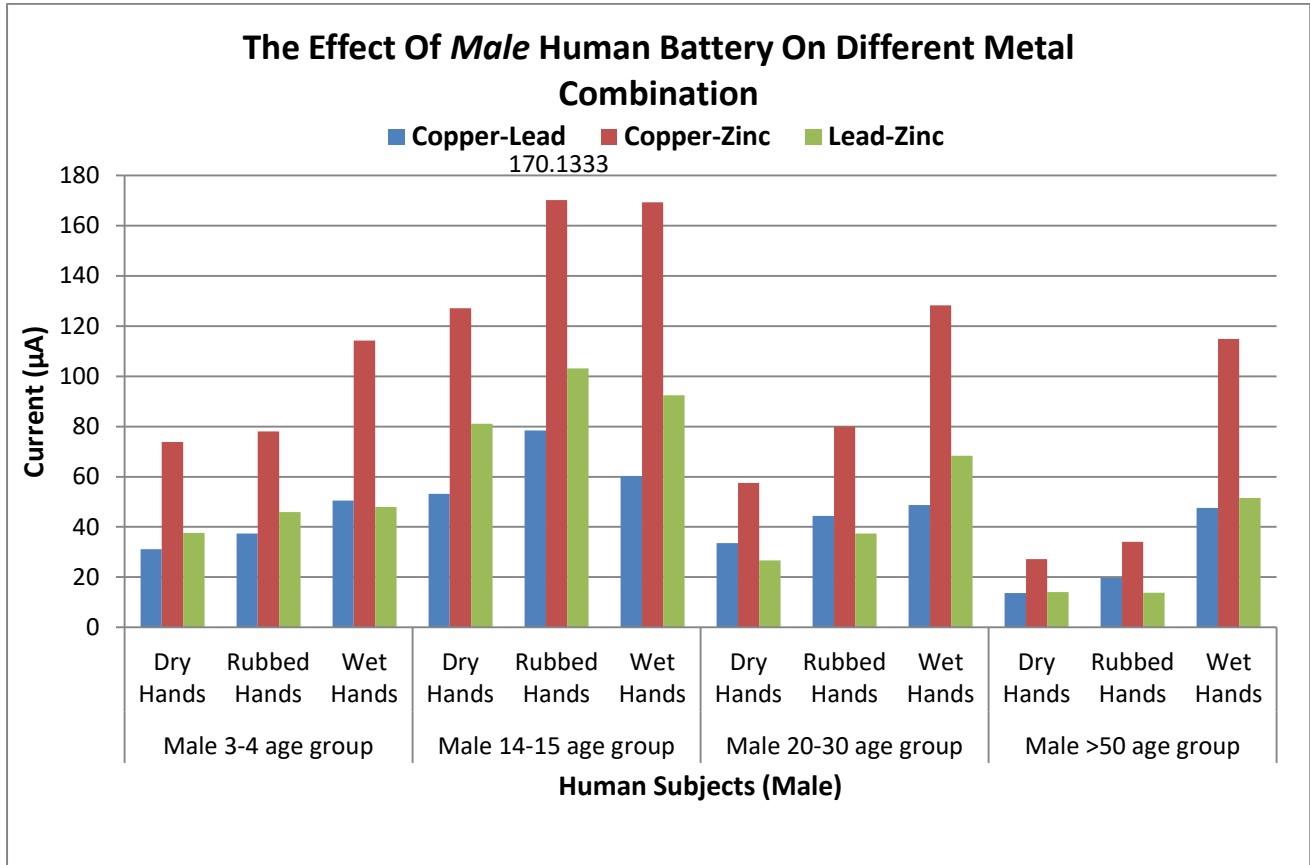
Consolidated readings

<i>Gender/ Age group</i>	<i>Experimental Conditions</i>	<i>Current (in μA)</i>		
		<i>Copper-Lead</i>	<i>Copper-Zinc</i>	<i>Lead-Zinc</i>
<i>Male 3-4</i>	<i>Dry Hands</i>	31.0794281	73.8745717	37.67165247
	<i>Rubbed Hands</i>	37.3334161	78.0583008	45.90413564
	<i>Wet Hands</i>	50.5521564	114.254484	47.90680609
<i>Male 14-15</i>	<i>Dry Hands</i>	53.1666667	127.09996	81.06664
	<i>Rubbed Hands</i>	<u>78.43333</u>	170.1333	<u>103.20007</u>
	<i>Wet Hands</i>	60.16671	169.233333	92.46676333
<i>Male 20-30</i>	<i>Dry Hands</i>	33.6	57.5	26.73334
	<i>Rubbed Hands</i>	44.33332	79.9667	37.36666
	<i>Wet Hands</i>	48.7333334	128.30013	68.33333
<i>Male >50</i>	<i>Dry Hands</i>	13.7333333	27.16666	14.099994
	<i>Rubbed Hands</i>	19.63334	34.10001	13.83333
	<i>Wet Hands</i>	47.56667	114.80004	51.56668
<i>Female 3-4</i>	<i>Dry Hands</i>	46.0666667	102.10003	58.8333
	<i>Rubbed Hands</i>	53.76667	111.1	84.7
	<i>Wet Hands</i>	43.49999	120.46671	70.96666
<i>Female 14-15</i>	<i>Dry Hands</i>	49.5333333	106.8668	66.76667
	<i>Rubbed Hands</i>	55.6	135.30007	77.16667
	<i>Wet Hands</i>	70.36664	<u>183.2</u>	89.9
<i>Female 20-30</i>	<i>Dry Hands</i>	41.266633	64.433303	36.233336
	<i>Rubbed Hands</i>	58.03336	105.86652	73.53332
	<i>Wet Hands</i>	60.13334	148.0999	76.68339
<i>Female >50</i>	<i>Dry Hands</i>	<u>9.89999999</u>	<u>13.766663</u>	<u>6.266663</u>
	<i>Rubbed Hands</i>	13.033326	18.466667	10.500004
	<i>Wet Hands</i>	28.800007	66.4333	28.43334

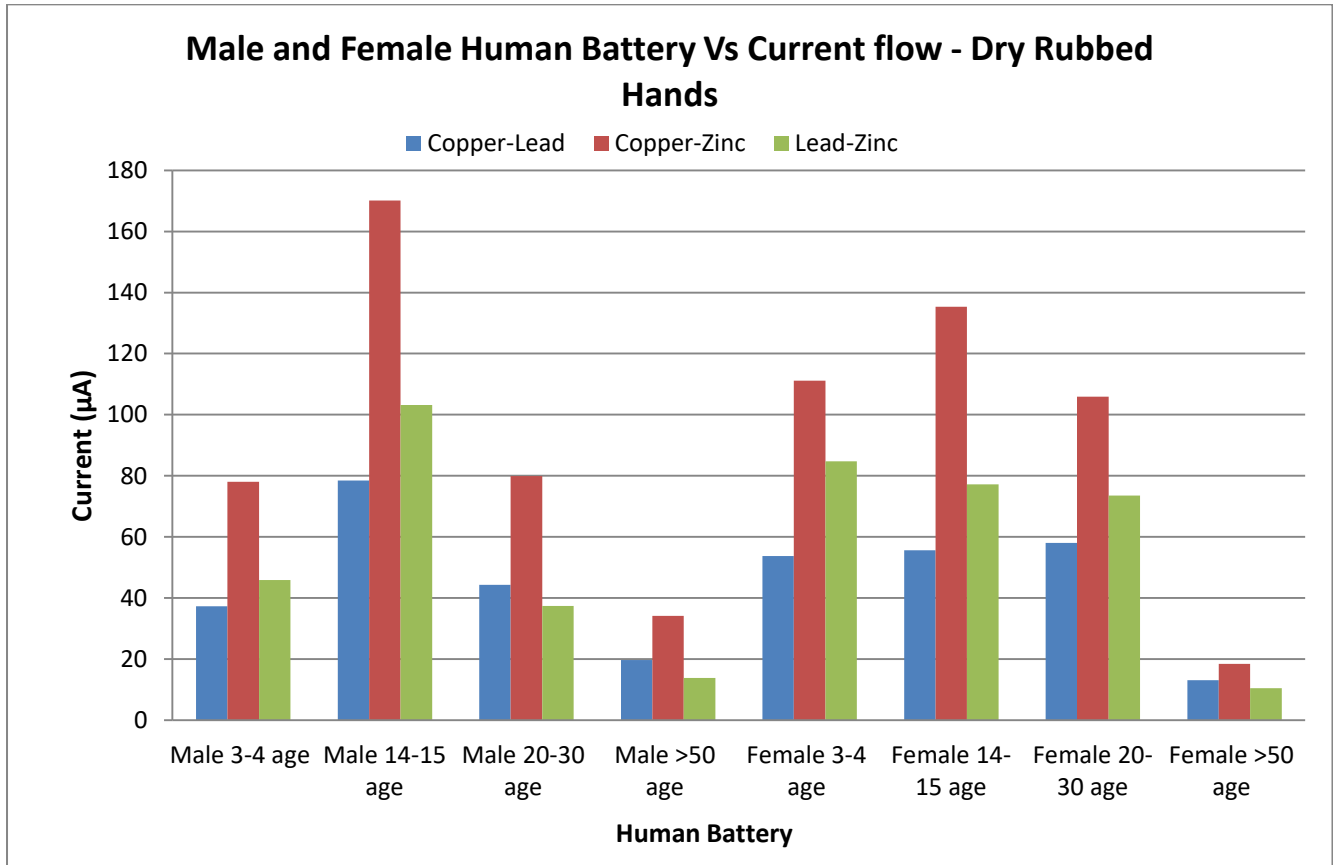
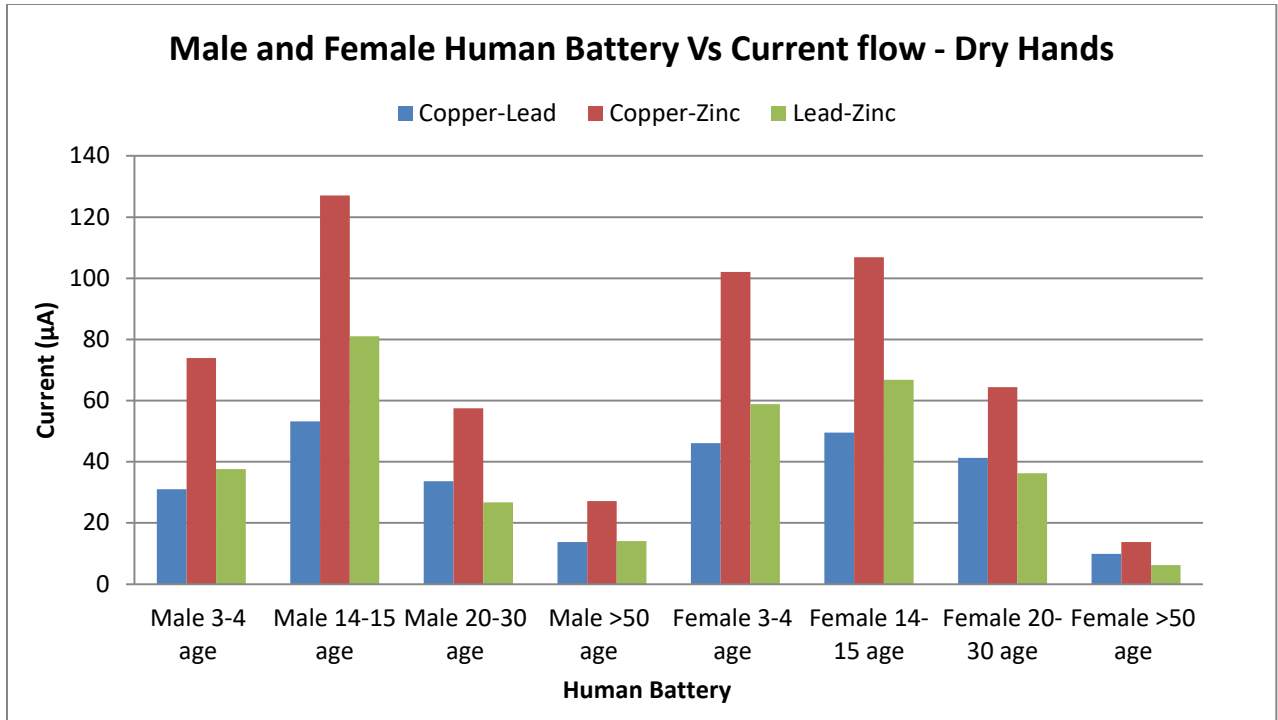
The following colour codes represent the degree to which the value of the current flow is. (experiment-wise)

	Highest reading
	In between
	Least reading

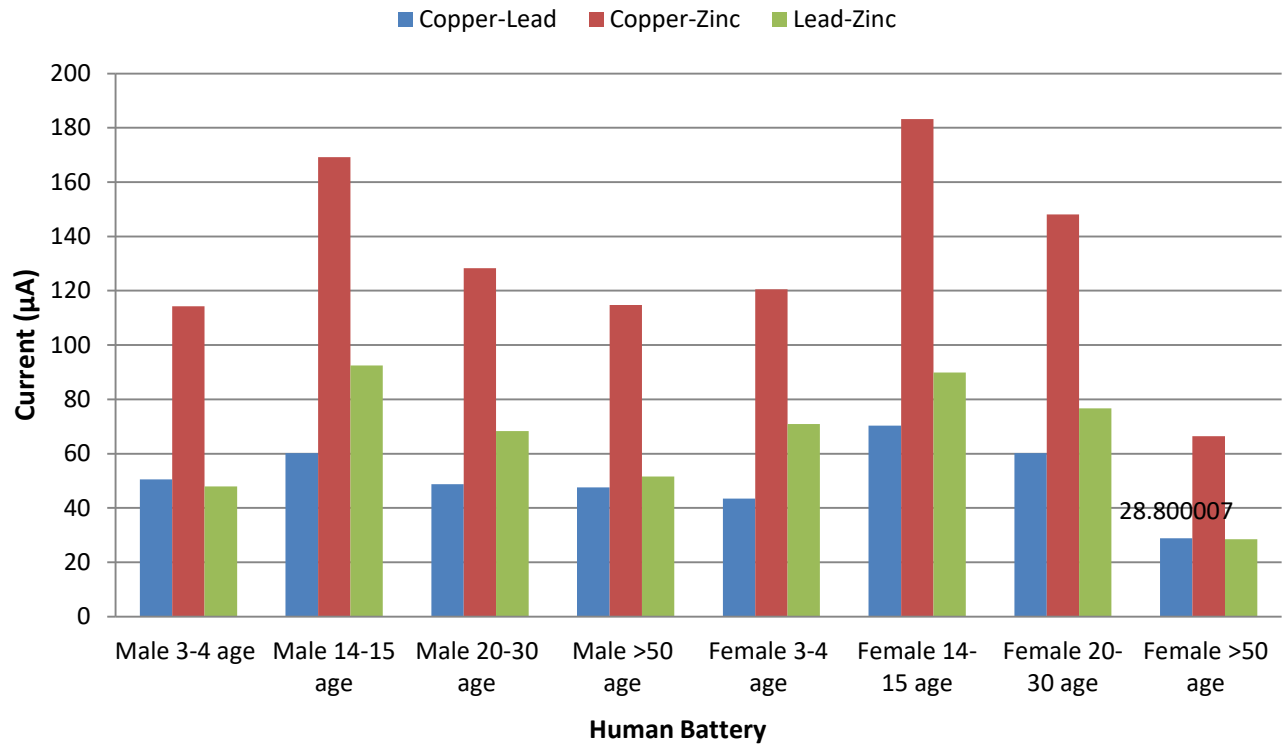
Result Graph 1: Male Vs female Battery



Result Table 2: Dry Hands Vs Rubbed Hands Vs Wet Hands

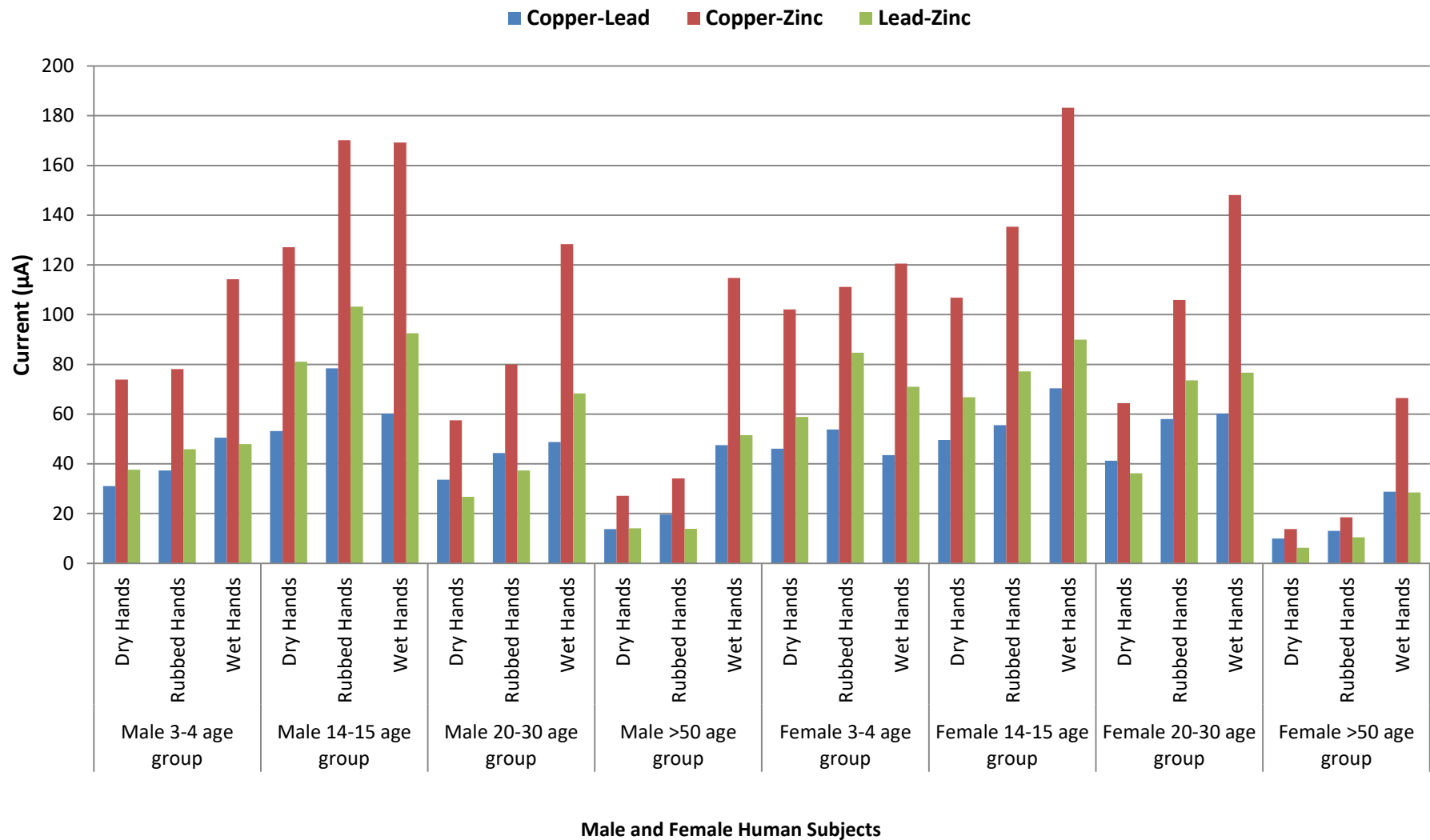


Male and Female Human Battery Vs Current flow - Wet Hands



Result Graph 3: CONSOLIDATED RESULT

Comparison of effect of Male and Female Human battery of different age groups on different metal combination



- For the purpose of comparing, I prepared a consolidated report, where I had considered the average of all 10 human subjects for each of the experimental conditions in every age group as the final reading. For instance, for a particular metal combination, Dry hands reading represent the average value of all the 10 human subjects and so on.

Result Table 1 shows the decreasing order of Current flow in different metal combinations

Gender/ Age group	Dry hands	Rubbed Hands	Wet Hands
Male 3-4	Cu-Zn, Pb-Zn, Cu-Pb	Cu-Zn, Pb-Zn, Cu-Pb	Cu-Zn, Cu-Pb, Pb-Zn
Male 14-15	Cu-Zn, Pb-Zn, Cu-Pb	Cu-Zn, Pb-Zn, Cu-Pb	Cu-Zn, Pb-Zn, Cu-Pb
Male 20-30	Cu-Zn, Cu-Pb, Pb-Zn	Cu-Zn, Cu-Pb, Pb-Zn	Cu-Zn, Pb-Zn, Cu-Pb
Male >50	Cu-Zn, Pb-Zn, Cu-Pb	Cu-Zn, Cu-Pb, Pb-Zn	Cu-Zn, Pb-Zn, Cu-Pb
Female 3-4	Cu-Zn, Pb-Zn, Cu-Pb	Cu-Zn, Pb-Zn, Cu-Pb	Cu-Zn, Pb-Zn, Cu-Pb
Female 14-15	Cu-Zn, Pb-Zn, Cu-Pb	Cu-Zn, Pb-Zn, Cu-Pb	Cu-Zn, Pb-Zn, Cu-Pb
Female 20-30	Cu-Zn, Cu-Pb, Pb-Zn	Cu-Zn, Pb-Zn, Cu-Pb	Cu-Zn, Pb-Zn, Cu-Pb
Female >50	Cu-Zn, Cu-Pb, Pb-Zn	Cu-Zn, Cu-Pb, Pb-Zn	Cu-Zn, Cu-Pb, Pb-Zn

Result Table 2 shows the decreasing order of Current flow in different experimental conditions

Gender/ Age group	Copper-Lead	Copper-Zinc	Lead-Zinc
Male 3-4	Wet, Rubbed, Dry	Wet, Rubbed, Dry	Wet, Rubbed, Dry
Male 14-15	Rubbed, Wet, Dry	Rubbed, Wet, Dry	Rubbed, Wet, Dry
Male 20-30	Wet, Rubbed, Dry	Wet, Rubbed, Dry	Wet, Rubbed, Dry
Male >50	Wet, Rubbed, Dry	Wet, Rubbed, Dry	Wet, Dry, Rubbed,
Female 3-4	Rubbed, Dry, Wet,	Wet, Rubbed, Dry	Rubbed, Wet, Dry
Female 14-15	Wet, Rubbed, Dry	Wet, Rubbed, Dry	Wet, Rubbed, Dry
Female 20-30	Wet, Rubbed, Dry	Wet, Rubbed, Dry	Wet, Rubbed, Dry
Female >50	Wet, Rubbed, Dry	Wet, Rubbed, Dry	Wet, Rubbed, Dry

Result Table 3 shows the Highest and the least value of Current flow in different metal combination at different experimental conditions

	Dry Hands			Rubbed Hands			Wet Hands		
	Copper-Lead	Copper-Zinc	Lead-Zinc	Copper-Lead	Copper-Zinc	Lead-Zinc	Copper-Lead	Copper-Zinc	Lead-Zinc
Highest	Male 14-15	Male 14-15	Male 14-15	Male 14-15	Male 14-15	Male 14-15	Female 14-15	Female 14-15	Male 14-15
Least	Female >50	Female >50	Female >50	Female >50	Female >50	Female >50	Female >50	Female >50	Female >50

Current flow Vs Metal combination (Cu-Pb, Cu-Zn and Pb-Zn):

- Among the three metal combinations, **Copper-Zinc combination works well in all the three experimental cases for all the considered age groups.**
- Out of 24 combination cases (Male 3-4 – Dry, Male 3-4 – Rubbed, Male 3-4 – Wet, and so on...), *Copper-Lead metal combination shows the least reading in 16 combination-cases.*
- *In remaining 8 cases, it is Lead-Zinc which shows the least reading.*

Current flow Vs Experimental conditions (Dry, Rubbed and Wet):

- Comparing all the experimental conditions, current flow when placing the **wet hands is very high.**
- The only exception is in case of Copper-Lead in Female 3-4 where it shows the least reading.
- In 5 out of 24 combination cases, Rubbed hands show the highest reading especially in all the cases of Male 3-4.
- **Dry hands show the least reading in all the cases except for Male >50 Lead-Zinc and Female 3-4 Copper-Zinc.**
- In most of the cases, dry and dry rubbed hands are of nearby values.

Current flow Vs Age Group:

- Conductivity increases with increasing age, from 3-4 group to 14-15, but again decreases from 14-15 to 20-30, which further decreases for above 50 age group.
- Age group 14-15 is more suitable for human battery comparing all others.
- Age group above 50 shows very minimum current value comparing all other ages in both genders.
- Copper-Zinc combination works well for all the considered age groups.

Current flow Vs Gender:

- In 19 out of 36 cases, Females stand first, while Males have the highest reading in the remaining 17 cases.

Overall result:

Highest reading (183.2 microampere) was recorded in Copper-Zinc metal combination with Wet hand condition for Female 14-15.

Lowest reading (6.27 microampere) was recorded in Lead-Zinc combination with Dry Hand condition for Female above 50.

Learning beyond the research:

- The very first thing I observed was most of the human subjects was afraid of keeping their hands on the metal plates which are connected to multimeters. I could understand the reason for their hesitation, and I humbly took the opportunity to clarify them by explaining how they could possibly become a human battery by simply being a component of completing the circuit. For proving this, I myself kept my hands on the plates and pointing out the change in multimeter readings.
- I felt very happy when I was an eye-opener for the misconception they had.
- I felt so excited when working with such small Kindergarten kids.

Possibility of error:

There is a possibility of error in readings as it involves humans. The way they place their hands, whether they press it too hard or just keep it on the plates may interfere with the readings. Readings could not be possibly taken at the same time for all the 80 subjects. For Above 50 age people, I visited their homes and measured the current flow. I ensured plates are kept on wooden table, equal time lapse of placing hand on the plate, but still the position of the person (whether sitting on the floor/ chair or standing and leaning forward/backward) and the angle of the hand placed with the ground level may have interfered with the accuracy. For age group 3-4, making them placing hands properly was challenging.

CONCLUSION

- *My hypothesis, “Copper-Zinc combination works well with human battery” has been proved.*

Females exhibit greater current value.

FUTURE ENHANCEMENT

- I would like to consider different ages ranging from 15 to 20 (from both genders), instead of age group.
- Also I want to take up different experimental conditions such as walking, jumping and to compare the current generated with the survey report of their body nature.

APPLICATION

- Currently, only a very small percentage of consumer disposable batteries are recycled (less than 2%) and most waste batteries are disposed of in landfill sites. The rate for recycling of consumer rechargeable batteries is estimated to be 5%.
- The key application is in health, especially implantable medical devices like pacemakers. If the device relies on batteries, replacing the battery needs surgery, so providing operations for medical devices is a huge advantage and can really affect people’s lives
- Pacemakers can vary from person to person on how strong they need to be. We can determine the strength of a pacemaker by the gender and type conditions the person undergoes the most.

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