Supplementary Information

Pilot study to detect genes involved in DNA damage and cancer in humans: Potential biomarkers of exposure to E-cigarette aerosols

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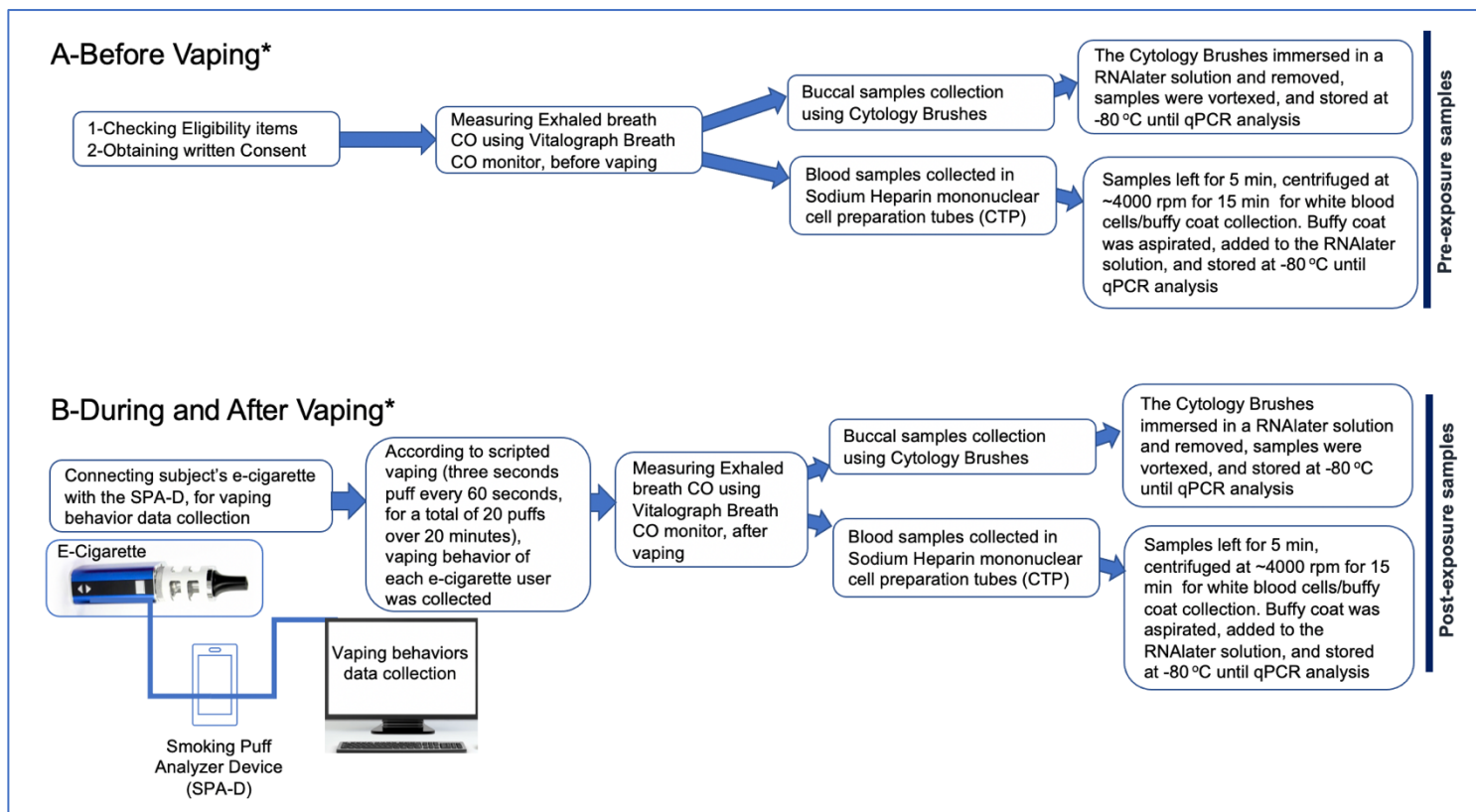
Supplementary Figure S1. The overview of the experimental study design, before vaping (A), and during and after vaping (B). [*] Blanks and duplicates of biological samples were collected in each session

Supplementary Table S1. Eligibility criteria

Eligibility item	Eligible for Study Participation
Age	18-59 years old
Type of E-cig	Cartomizer or tank style
Combustible cigarette smoker	No; should quit at least 2 months before participation
Past cigarette smoker	If yes, at least 100 cigarettes in lifetime; must have quit at least 2 months before participation in the study
Daily e-cig use	Yes
E-liquid-Levels of nicotine level	Maximum 6 mg/ml

Supplementary Table S2. Eligibility screening survey; *DK: Do not Know

QUESTION	RESPONSE				ELIGIBLE RESPONSE
How did you find out about this study	Newspaper	Poster or Flyer	Friend	Other	
How old are you?	Age:		Comments		≥18 ½ years
Do you use electronic cigarettes every day?	Yes	No			Yes
How long have you been using electronic cigarettes?					≥2 months
How many times do you use an electronic cigarette per day					≥8
Are you willing to use your own electronic cigarette during a test session in our lab?	Yes	No			Yes
What type of electronic cigarette do you vape? Brand, style, model, etc.					Will not determine eligibility
Do you use an electronic cigarette containing nicotine?	Yes	No	DK*		Yes
Are you willing to use a commercially available electronic cigarette during a test session in our lab?	Yes	No			Yes
Could you come to the lab twice, one week apart, for about 3 hours each time?	Yes	No			Yes
Are you willing to use a recording device when you vape electronic cigarettes on your own time for one week?	Yes	No			Yes
Do you have any mouth or throat problems that would keep you from comfortably vaping an electronic cigarette?	Yes	No			No
Do you have a history of problems resulting from blood draws?	Yes	No			No
Will you have difficulty having two small samples (~2 teaspoons each) of your blood drawn during each lab visit?	Yes	No			No
Do you have respiratory allergies, a history of pulmonary disease, or asthma?	Yes	No			No
Do you suffer from claustrophobia, i.e., are you uncomfortable in closed-in spaces?	Yes	No			No
Are you in the process of trying to stop using electronic cigarettes?	Yes	No			No
WOMEN: Are you pregnant, breastfeeding, or trying to become pregnant?	Yes	No			No

Supplementary Table S3. Laboratory visit dates and subjects' e-cigarettes vaped in this study

Subject ID_ Male/Female	Visit # (date)	E-Cigarette Type (nicotine Conc. mg/ml)	CO Conc. ppm; before/ after vaping
S01_M	V1 (05/18/2017)	EVOD brand (6)	0/0
	V2 (05/23/2017)		0/0
	V3 (05/25/2017)		0/0
S02_F	V1 (05/22/2017)	Vaporfit Pro brand (3)	1/1
	V2 (06/05/2017)		1/0
	V3(06/06/2017)		0/0
S03_M	V1 (05/30/2017)	Smok Alein 220 brand (6)	0/0
	V2 (06/02/2017)		0/0
	V3 (06/05/2017)		0/0

Supplementary Table S4. Number of buccal and blood samples, duplicates, and method blanks collected

Subject ID_ Male/Female	Visit number	Sampling date	Number of Blood¥ samples	Number of Buccal¥ Samples	Duplicates (Dup) and Method Blanks (Blk)*
S01_M	V1	05/18/17	3	2	Pst**-Blood Dup + One Buccal Blk
	V2	05/23/17	3	3	Pre***-Blood Dup + Pst Buccal Dup
	V3	05/25/17	2	3	Pre-Buccal Dup
S02_F	V1	05/22/17	3	3	Pre-Blood Dup + Pst Buccal Dup
	V2	06/05/17	2	3	Pre-Buccal Dup
	V3	06/06/17	3	2	Pst-Blood Dup
S03_M	V1	06/02/17	3	2	Pst-Blood Dup
	V2	06/05/17	2	2	None
	V3	06/07/17	2	3	Pre-Buccal Dup + One Buccal BLK + 2 Blood Blks
Total samples:			23 + 2Blks=25	23 + 2Blks=25	

* Blanks of blood or buccal was performed by using RNA-Later solution only; **Pst: post exposure; ***Pre: pre-exposure

SUPPORTING MATERIALS AND METHODS

***Quantitative RT-PCR analysis of gene expression*:** The fifty biologic (25 buccal epithelial and 25 blood) samples were shipped to Battelle Eastern Science and Technology (BEST), June 26, 2017, and extracted for RNA. The RNA extraction was performed using the RNeasy Mini Kit, followed by cDNA synthesis using the RT^2 First Strand Kit (Qiagen, Alameda, CA, USA). After cDNA synthesis, samples were diluted in water and aliquoted within the 96-well array. The Human DNA Damage Signaling Pathway RT2 Profiler TM PCR Array (QIAGEN, PAHS-029ZA) comes pre-loaded with SYBR-based primers in each well that are specific to 84 DNA damage related genes , 5 house-keeping genes [Beta-2-Microglobulin (B2M), Hypoxanthine phosphoribosyl transferase 1 (HPRT1), Ribosomal Protein L13a (RPL13A), Glyceraldehyde-3-phosphate Dehydrogenase (GAPDH), and Actin beta (ACTB), a human genomic DNA contamination negative control (HGDC), reverse transcription control (RTC) and positive PCR controls (PPC). Positive control RTC and PPC genes had robust expression with approximate cycle threshold (Ct) values in the 18 to 26 range for all samples.

The fold changes for each of the 84 genes relative to each of the five house-keeping genes was summarized in the accompanying Excel files. For buccal (BUCL) samples the house-keeping gene B2M had relatively robust signaling according to Ct values (average of 26); for WBC/blood samples, while HPRT1 was the most appropriate house-keeping gene for the respective 25 buccal samples. The reportable values for each sample from each array was expressed as a relative cycle threshold (Ct) value and converted to fold-change values relative to appropriate house-keeping genes.

Supplementary Table S5. Genes, their abbreviations, and the catalog numbers of their primers, examined in the PCR-bioassay

GENE ID	GENE OFFICIAL NAME	RT2 qPCR ASSAY CATALOG #
ABL1	Tyrosine-protein kinase ABL1	PPH00087E
ANKRD17	Ankyrin repeat domain-containing protein 17	PPH12069A
APEX1	DNA-apurinic or apyrimidinic site lyase	PPH02201A
ATM	Ataxia Telangiectasia Muted	PPH00325C
ATR	Ataxia Telangiectasia And Rad3 Related	PPH01318B
ATRX	Alpha thalassemia/metal retardation syndrome X-linked	PPH00470F
BRCA1	Breast cancer type 1 susceptibility protein	PPH00322F
BTG2	BTG anti-proliferation factor 2	PPH01750C
CCNH	Cyclin-Dependent Kinase-Activating Kinase Complex Subunit	PPH00959E
CDK7	Cyclin Dependent Kinase 7	PPH00935E
CHEK1	Checkpoint Kinase 1	PPH00940C
CHEK2	Checkpoint Kinase 2	PPH00921B
CIB1	Calcium And Integrin Binding 1	PPH12320C
CIDEA	Cell Death Inducing DFFA Like Effector A	PPH00899C
CRY1	Cryptochrome Circadian Regulator 1	PPH06231B
DDB1	Damage Specific DNA Binding Protein 1	PPH01515A
DDIT3	DNA Damage Inducible Transcript 3	PPH00310A
DMC1	DNA Meiotic Recombinase 1	PPH02712F
ERCC1	Excision Repair 1, Endonuclease Non-Catalytic Subunit	PPH01539A
ERCC2	ERCC Excision Repair 2, TFIIH Core Complex Helicase Subunit	PPH01550C
EXO1	Exonuclease 1	PPH02715A
FANCG	FA Complementation Group G	PPH20387A
FEN1	Flap Structure-Specific Endonuclease 1	PPH00502B
XRCC6	X-Ray Repair Cross Complementing 6	PPH02175A
GADD45A	Growth Arrest And DNA Damage Inducible Alpha	PPH00148B
GADD45G	Growth Arrest And DNA Damage Inducible Gamma	PPH02207A
GML	Glycosylphosphatidylinositol Anchored Molecule Like	PPH01755F
GTF2H1	General Transcription Factor IIH Subunit 1	PPH02600F
GTF2H2	General Transcription Factor IIH Subunit 2	PPH73147A
GTSE1	G2 And S-Phase Expressed 1	PPH01748F
HUS1	HUS1 Checkpoint Clamp Component	PPH00922B
IGHMBP2	Immunoglobulin Mu DNA Binding Protein 2	PPH08993F
IP6K3	Inositol Hexa-kis-phosphate Kinase 3	PPH08133A
XRCC6BP1	ATP23 Metallopeptidase And ATP Synthase Assembly Factor Homolog	PPH09665E
LIG1	DNA Ligase 1	PPH02094A
MAP2K6	Mitogen-Activated Protein 2 Kinase 6	PPH00742B

MAPK12	Mitogen-Activated Protein Kinase 12	PPH01779A
MBD4	Methyl-CpG Binding Domain 4, DNA Glycosylase	PPH02709A
MLH1	MutL Homolog 1	PPH00196F
MLH3	MutL Homolog 3	PPH02700A
MNAT1	MNAT1 Component Of CDK Activating Kinase	PPH02714A
MPG	N-Methylpurine DNA Glycosylase	PPH02102A
MRE11A	MRE11 Homolog, Double Strand Break Repair Nuclease	PPH01097C
MSH2	MutS Homolog 2	PPH00197E
MSH3	MutS Homolog 3	PPH02195A
MUTYH	MutY DNA Glycosylase	PPH02697E
N4BP2	NEDD4 Binding Protein 2	PPH19003B
NBN	Nibrin	PPH00946C
NTHL1	Nth Like DNA Glycosylase 1	PPH02720A
OGG1	8-Oxoguanine DNA Glycosylase	PPH02103A
PCBP4	Poly (RC) Binding Protein 4	PPH01756C
PCNA	Proliferating Cell Nuclear Antigen	PPH00216B
AIFM1	Apoptosis Inducing Factor Mitochondria Associated 1	PPH01037A
PMS1	PMS1 Homolog 1, Mismatch Repair System Component	PPH02155B
PMS2	PMS1 Homolog 2, Mismatch Repair System Component	PPH02095E
PMS2P3	PMS1 Homolog 2, Mismatch Repair System Component Pseudogene 3	PPH02741C
PNKP	Polynucleotide Kinase 3'-Phosphatase	PPH02725A
PPP1R15A	Protein Phosphatase 1 Regulatory Subunit 15A	PPH02081E
PRKDC	Protein Kinase, DNA-Activated, Catalytic Subunit	PPH01309C
RAD1	RAD1 Checkpoint DNA Exonuclease	PPH00741F
RAD17	RAD17 Checkpoint Clamp Loader Component	PPH00929F
RAD18	RAD18 E3 Ubiquitin Protein Ligase	PPH02740A
RAD21	RAD21 Cohesin Complex Component	PPH10216A
RAD50	RAD50 Double Strand Break Repair Protein	PPH00956B
RAD51	RAD51 Recombinase	PPH00942F
RAD51B	RAD51 Paralog B	PPH02654B
RAD9A	RAD9 Checkpoint Clamp Component A	PPH00944C
RBBP8	RB Binding Protein 8, Endonuclease	PPH00954F
REV1	REV1 DNA Directed Polymerase	PPH21080A
RPA1	Replication Protein A1	PPH02730A
SEMA4A	Semaphorin 4A	PPH19432A
SESN1	Sestrin 1	PPH01759B
SMC1A	Structural Maintenance Of Chromosomes 1A	PPH14489A
SUMO1	Small Ubiquitin Like Modifier 1	PPH00973F
TP53	Tumor Protein P53	PPH00213F
TP73	Tumor Protein P73	PPH00725A
TREX1	Three Prime Repair Exonuclease 1	PPH02340B
UNG	Uracil DNA Glycosylase	PPH01727E
XPA	DNA Damage Recognition And Repair Factor	PPH01524C

XPC	Complex Subunit, DNA Damage Recognition And Repair Factor	PPH01536F
XRCC1	X-Ray Repair Cross Complementing 1	PPH01741A
XRCC2	X-Ray Repair Cross Complementing 2	PPH01694A
XRCC3	X-Ray Repair Cross Complementing 3	PPH02208A
ZAK	Sterile alpha motif and leucine zipper containing kinase	PPH05541E

Supplementary Table S6A. The expression data of eighty-four genes analyzed in human buccal samples

GENE ID_Buccal	S01_V1	S01_V2	S01_V3	S02_V1	S02_V2	S02_V3	S03_V1	S03_V2	S03_V3
ABL1	0.120309009	1.575353818	1.890530097	0.568191141	3.176353404	2231.628876	3.238911294	13.81549776	0.402849938
ANKRD17	0.13200939	0.621804617	3.681536873	0.523439044	8.511715308	10.61202304	2.061779428	0.007006468	0.001262416
APEX1	331.0232118	3.435630297	2.38827987	0.457142576	0.689381733	6.384056903	2.061779428	2.815950212	1.266454738
ATM	0.098133556	0.507455341	9.433798232	0.549357985	4.826227769	47.14027618	7.20691785	1.619864637	0.599583071
ATR	0.146976155	2.081903632	10.95905862	0.715768408	4.0693953	5.732655374	1.883156232	1.952197933	0.946047691
ATRX	0.13200939	0.047860167	2.38827987	0.327209944	6.054709583	0.00606395	2.061779428	2.815950212	0.044373325
BRCA1	0.033486775	0.987445738	2.38827987	2.044983543	0.146308947	18981.96874	0.001391494	2.815950212	0.023869228
BTG2	0.318069937	77.57168264	3.160996439	0.651070681	0.230692978	1.886206514	0.832266203	56.36078783	2.395299775
CCNH	0.043200211	3.523177999	1.877575208	3.535515036	7.868484742	0.401584744	5.419608179	16.21225032	3.416940387
CDK7	0.049782138	13.29625733	3.518151058	1.19699613	18.90785493	93.4142678	0.639300698	3.374159202	1.469479753
CHEK1	0.771947945	3.520370405	2.775243364	0.009119023	3.0538533	0.01613128	3.630706911	0.203360883	0.817502628
CHEK2	0.001682382	4.967004392	0.151624817	13.26195302	45.30274289	0.759034323	46.75066736	3.995803298	4.438646397
CIB1	0.017293089	2.939631777	12.38991151	0.044443485	23.29191785	9.6456544	4.081750944	2.654260439	11.33955471
CIDEA	0.13200939	4.950176131	2.38827987	0.914501544	6.054709583	315.3146601	2.061779428	2.815950212	1.3246043
CRY1	0.13200939	0.036410565	0.032957525	1120.480546	1.733152677	4.780552819	2.290474158	1.021078757	1.32930942
DDB1	0.178217997	3.767706937	0.857658726	1.523887726	0.921712049	1.257812879	4.563563327	3.021071541	0.82171559
DDIT3	0.13200939	3.435630297	2.38827987	0.327209944	6.054709583	6.384056903	2.061779428	2.815950212	0.039505301
DMC1	0.010672731	3.435630297	0.073413402	0.468522087	6.054709583	3.302305315	2.061779428	2.815950212	0.191353877
ERCC1	0.351517569	0.060570279	0.147928056	5.607316134	0.039094002	1.40012115	0.009576426	1.860525278	1.265987681
ERCC2	0.068194589	0.083109084	14.03347657	8.987923365	3.694082346	8.756778057	58.91284543	0.330856563	5.814433026
EXO1	0.39838033	1.794177661	2.518960539	0.12915611	12.69419838	48.42035898	3.287896747	1.753760216	1.998913551
FANCG	0.037200278	1.132324103	0.977885325	18.19844569	1.958324343	8.692042086	0.511956755	0.218433696	0.648344343
FEN1	2.252745388	110.2662338	0.210669265	0.920755422	6.054709583	7.465073967	2.061779428	11.17801478	24.35435232
XRCC6	0.13200939	6.026530466	0.037052095	542.8485325	0.011580974	0.002854539	0.001317913	1.800327	0.001532143
GADD45A	0.110732124	0.973303937	3.42341097	0.5354124	0.618465519	2.702835128	7.885177016	0.159381005	4.60229201
GADD45G	0.13200939	3.435630297	2.38827987	1.985517814	6.054709583	6.384056903	2.061779428	2.815950212	1.3246043
GML	0.13200939	3.435630297	2.38827987	0.327209944	6.054709583	6.384056903	2.061779428	2.815950212	1.3246043
GTF2H1	0.13329841	1.711886535	3.795569599	0.686519529	7.458819049	16.47050409	2.206377674	2.354891439	2.563512392
GTF2H2	0.377422815	166.2985917	1.58280675	0.327209944	10.17867543	5.078750181	6.899707788	2.815950212	1.3246043
GTSE1	0.129233656	5.086139276	3.86190886	0.378737919	3.062969805	22.87107739	0.412263783	2.018103951	0.994394315
HUS1	0.13200939	3.435630297	2.38827987	1.461999801	6.054709583	0.004874512	2.061779428	2.815950212	1.3246043
IGHMBP2	0.101131041	0.012666843	24.42693852	2.210500315	2.122186025	1.160793805	0.024468767	1.010750303	1.350447306
IP6K3	0.13657792	9.026338798	5.367788583	199.9484262	192.4642434	0.042944689	14.32814819	1.578153413	82.62898551
XRCC6BP1	0.051863987	1.956864695	4.450975004	0.161331832	0.890986977	6.668257774	0.027761354	184.7309282	0.039510055
LIG1	0.248132311	4.400811869	0.710651226	0.389600152	7.930345916	0.017407963	104.8214445	0.014001085	1.250715716
MAP2K6	0.023650255	32.18018042	1.086010181	0.391385894	41.81235504	2.706038801	3.044873664	9.566959264	13.83381152
MAPK12	0.138333374	3.247817393	1.921780876	0.757400733	7.04343841	38.92061127	4.687141234	4.273541942	1.57565376
MBD4	0.13200939	0.001412489	2.38827987	0.327209944	6.054709583	6.384056903	2.061779428	8543.275421	0.00100669
MLH1	0.017093063	22.70496989	3.290349279	0.000954389	3.502991571	13.091698	0.16134783	5.16790416	4.465681111
MLH3	0.539246353	10.40046609	1.503824695	0.746779601	2.992343909	58.59670556	5.171341974	0.597745261	1.805699892
MNAT1	0.11701877	4.340056813	0.056413725	1.719830776	6843.006653	165.2152342	0.848004655	10.17600447	1.3246043
MPG	0.050214571	6.760462929	18.66403418	0.154273703	0.469225853	17.84536995	0.018739671	0.298385436	20.71333601
MRE11A	0.453968584	1.734566002	2.540502272	0.273114674	5.478122727	1.824733597	2.295324366	16.1421424	1.243862457
MSH2	0.028924873	3.435630297	0.057477033	3.098583751	6.054709583	44.81995911	2.061779428	2.815950212	0.633953614
MSH3	0.000408053	116.5218076	2.616050039	0.087397282	1.860378849	0.00602301	0.375523003	0.205750986	0.551102396
MUTYH	0.070364982	2.079218993	2.201112959	0.387845119	20.34146042	125.4343017	2.688059682	1.639709159	2.067538945
N4BP2	0.269595374	4.096293033	1.584050234	0.515117862	15.86827301	3.368172586	1.729782067	0.590968737	1.064826318
NBN	0.13176737	2.852136441	0.81897167	1.619198743	0.904679245	1.116038794	2.22035918	1.222906175	0.63881658
NTHL1	0.102785223	3.435630297	2.38827987	15.58309882	3.743954664	6.384056903	2.061779428	2.815950212	1.3246043
OGG1	0.019365535	31.30387497	0.711258424	0.109757489	17.69910421	0.16490203	32.07984692	40.04206207	2.307275228
PCBP4	0.131828008	62.72406981	2.68502289	14.28594892	0.335132135	50.55740766	2.172988297	0.225245662	1.621885406
PCNA	0.13200939	3.435630297	2.38827987	0.327209944	6.054709583	6.384056903	2.061779428	2.815950212	1.3246043
AIFM1	0.529027003	2.690331528	19.14684938	21.58209028	27.94763896	2.223229136	1.020777764	0.88595069	2.688919842
PMS1	0.051538083	9.73198379	7.564050187	0.099268546	11.27608445	1.404625931	1.56648146	4.461662325	2.386007566
PMS2	0.057670751	0.065785419	0.79486846	46.39459571	2.382810426	1.513228403	2.127646089	0.21538851	1.775238014
PMS2P3	0.843408215	9.267125847	5.883820191	1.0286454	2.991975888	0.719458663	20.46930975	1.009277453	1.256213375
PNKP	0.13200939	0.0081194754	2.38827987	0.327209944	8.597999703	6.384056903	2.6001784	757.1913712	0.731926332
PPP1R15A	0.128295319	1.365349454	6.352355448	0.869228687	9.11481922	0.891851583	1.646144994	0.893370093	0.768630073
PRKDC	0.009980137	0.828142562	1.729416202	0.061695861	6.054709583	6.384056903	0.774748358	24.92811421	1.3246043
RAD1	0.120085265	4.493017108	2.438452584	0.266685655	7.927792849	6.792302425	2.005183946	2.929408907	1.671348484
RAD17	0.011071764	0.121310765	0.02091673	102.4318243	0.005740002	0.314960936	0.006338674	0.961070847	0.524404269
RAD18	0.13200939	3.435630297	2.38827987	0.327209944	6.054709583	6.384056903	3.349505179	2.815950212	1.3246043
RAD21	0.13200939	3.435630297	2.38827987	0.327209944	6.054709583	0.011129044	2.061779428	2.815950212	0.036012637
RAD50	0.13200939	3.435630297	1.72340198	0.327209944	6.054709583	6.384056903	2.061779428	0.882068191	1.3246043
RAD51	0.13200939	3.435630297	0.081742053	5.873863928	2450.083489	0.004342792	0.484494974	3.709272271	0.785971957
RAD51B	0.063806792	5.419171124	1.847517068	7.227441906	4.806317192	43.2666999	11.89339131	0.436652589	2.210415566
RAD9A	0.495519855	3.511896037	1.27834786	578.7459662	4.83042156	0.009306623	213.288432	1.302661367	3.991167739
RBBP8	0.13200939	3.435630297	2.38827987	0.327209944	6.054709583	2914.749076	2.061779428	2.815950212	0.05075701
REV1	332.9517849	3.435630297	18.4199774	10.53006483	6.054709583	6.384056903	0.002026414	2.815950212	1.3246043
RPA1	0.087548199	5.275393244	0.508836574	3.110589372	12.40014056	2.12566414	1.504114996	0.002236031	0.022672397
SEMA4A	0.083010144	3.435630297	1.38979915	0.327209944	0.111418273	6.384056903	0.12822054	3.25324936	0.054193794
SESN1	0.060721014	1.230943576	1.261907027	1.718619298	17.97812655	1.702502109	2.659132063	1.473487293	8.854881074
SMC1A	0.005292859	1.565626369	0.329971106	0.932952568	0.439427787	1.117522181	2.534698308	1.611116434	0.839001947
SUMO1	0.035529322	10.3565037	2.760288293	1.726756862	6.054709583	6.384056903	2.061779428	2.815950212	0.02896762
TP53	0.578940431	2.983353253	0.115444936	3.587107848	115.8479575	21.5398561	2348.169666	6.979056065	45.51349845
TP73	0.13200939	3.435630297	0.347283082	38.11605664	2.423442348	6.384056903	0.008500162	0.417063358	4.34361001
TREX1	0.967948993	3.638505773	2.507344848	4.967496922	30.49202199	1.914781104	1.35715735	0.747445336	14.10719619
UNG	0.263795482	23.69860937	0.102467733	0.327209944	6.019141624	6.384056903	2.061779428	2.815950212	6.221524198
XPA	0.038500719	3.435630297	2.38827987	4.013311582	21.70373989	1.585262319	2.061779428	1.1692644	2.366407729
XPC	0.03008282	11.40614783	1.541201892	0.285839531	1.440598794	108.813424	9.542364844	4.029127694	1.455983589
XRCC1	0.080607921	3.059323323	2.939433577	0.200712286	15.87626316	11.98660807	8.571356509	2.196740618	0.292607252
XRCC2	1.26658032	3.435630297	2.38827987	0.792750053	1.016652725	10.14047383	16.31608517	3.504359287	1.3246043
XRCC3	0.082172215	1.42429331	3.055640865	0.693654006	11.11530201	15.03783237	0.382627313	3.159964377	2.838034937
ZAK	0.092636356	3.941061573	5.233476787	0.378277537	4.088713384	2.676195597	1.610828908	0.730180823	2.000158655

Supplementary Table S6B. The expression data of eighty-four genes analyzed in human blood/White Blood Cells (WBC) samples

GENE ID_WBC	S01_V1	S01_V2	S01_V3	S02_V1	S02_V2	S02_V3	S03_V1	S03_V2	S03_V3
ABL1	2.2524312	0.931575842	0.934189286	0.898421717	0.470798394	0.411541689	0.819092946	337.2539959	2532.550819
ANKRD17	0.066385602	0.835737219	0.767729245	0.581029912	0.740894922	0.010442532	0.170616229	0.627245735	2.191116485
APEX1	0.007567257	39.84859063	2.304894106	0.729324575	0.298198507	0.002658644	112.785526	1.236371488	7.228387934
ATM	13.80780117	0.530592151	6.696840848	0.631369065	1.373091701	1.783679036	0.584596646	1806.745552	10235.9389
ATR	3.107410036	1.174435085	1.255885409	1.863996761	1.187723866	3.640690337	0.115985581	1486.314053	32273.01394
ATRX	0.12141257	0.903343051	0.894670249	0.9092447	0.871418338	0.038415961	0.264778187	0.319232247	114160.724
BRCA1	0.014056754	29.96656926	0.652659865	0.920288095	3.429893807	0.009313075	38.48855017	2.044234778	87421.06196
BTG2	2.915520817	0.734445122	1.060524413	1.158553845	0.786372117	0.176577218	0.090971007	47.37623141	7372.180072
CCNH	8.157810698	0.981868239	2.492933486	0.597577748	1.080433601	1.151530199	2.719044901	13.80423279	1035.770765
CDK7	6.155983011	0.453809264	1.133099822	0.184842357	1.999555833	4.515807469	0.135978316	2627.995214	138.4197028
CHEK1	1860.799287	726.6181135	0.055988201	0.023683078	0.044745995	0.100604425	0.364661564	174.278351	94948.94999
CHEK2	0.239756044	18.75001503	0.000865349	5.495126797	0.001641937	0.049710976	0.034744843	27831.97746	3181.115081
CIB1	140.0901616	0.264396201	1.755388628	5.205109771	1.086771414	4.887061069	0.004207051	13784.51638	498.7455333
CIDEA	6.308071033	0.244680375	0.652659865	2.618354488	1.108693766	0.161577091	0.025381961	900.4704613	11360.08028
CRY1	0.158398016	0.536087056	0.250348609	0.992625697	1.776879322	0.075139167	60.61673372	0.629880854	17.07237292
DDB1	2.418479491	0.421171451	0.657455074	1.267398583	0.454357667	1.46527388	0.272937442	229.2400663	1634.095236
DDIT3	6.308071033	0.209165496	16.89545959	0.032511944	1.108693766	1.68161274	0.025381961	900.4704613	11360.08028
DMC1	0.010589098	0.730946265	0.856970262	1.181140812	0.002664792	0.013465093	40.71510501	4.990621841	11360.08028
ERCC1	0.616229401	0.903200345	1.038834601	0.481565081	1.478703664	0.469388837	0.902918582	0.565226442	16.90888948
ERCC2	0.358647971	5.023896968	0.302232609	2.344249259	0.820123433	0.778461001	0.658290909	463.554769	72281.95392
EXO1	0.396841956	1.204977935	0.984924173	0.772485974	1.367978391	1.332834246	0.03176808	352.7633422	21988.1771
FANCG	0.26824276	0.798587198	0.830187005	0.551952596	2.704267533	1.536479913	0.749154859	20.54191004	20289.35582
FEN1	0.005490338	41.82831138	1.253380747	1.171575413	1.251986278	0.107206715	10.81815706	0.454834268	5187473.284
XRCC6	219.2641975	0.122197775	1.184005048	0.652020795	0.432177461	0.012147624	31.95620063	1.065591016	3.753576972
GADD45A	1.359593449	3.230544234	2.175566772	0.611512507	0.011561525	0.173385075	22.06981466	104.1971989	2935.7902
GADD45G	0.006885015	32.19615987	1.163235709	0.32683337	1.108693766	0.013533232	46.37325532	1.634676726	11360.08028
GML	0.063156153	0.244680375	0.652659865	0.137895505	1.108693766	0.096422717	0.66687631	900.4704613	11360.08028
GTF2H1	40.88255854	0.620493564	1.456543848	2.709685867	1.477173727	40.16724525	0.049917111	3420.799962	7498.513136
GTF2H2	203.9921686	16.27866998	0.616208626	0.089063065	0.009649567	0.034599807	1.061959723	1967.984272	23.44819479
GTSE1	5.678858361	0.150746453	3.785476747	1.050705042	2.199873634	58.20243252	0.017634183	16690.64945	79744.22915
HUS1	0.004069496	24.79458614	0.757787349	0.829370268	3.938051128	0.128681606	49.07183094	0.603728055	3225.625163
IGHMBP2	0.912936575	6.454676586	0.394122329	0.012545828	1.505577291	0.067190924	7.999270249	33.56761978	11360.08028
IP6K3	0.066238493	4.486692389	0.783086455	0.093462665	1.108693766	0.303669685	0.620306965	2152.302003	2924.084221
XRCC6BP1	4.201106356	0.531260031	1.097155552	0.888375061	0.959390036	0.538791699	0.209128997	180.8530844	135.5045222
LIG1	0.111493574	1.101635903	1.014941544	1.65594794	0.78008159	0.123710242	2.768914099	16.799172	12.03842553
MAP2K6	0.939740667	2.579564318	0.592328205	0.34674952	1.044878663	0.682767695	7.819732287	143.0378875	12272.44946
MAPK12	26.47687095	0.126688602	2.067618216	2.695476039	1.910770502	14.38052599	0.013134369	8445.405823	1785.016349
MBD4	0.046524973	0.683371396	0.914641803	1.202461128	0.160384195	0.033386473	321.581058	0.19328139	7.895608692
MLH1	0.058806828	0.582256811	2.911655359	1.553114573	0.012310169	0.53249904	8.176744526	20.18263943	5856.617564
MLH3	7.175425115	5.952362899	0.656608146	0.652618449	0.446385148	1.335344081	1.635941495	14.14194796	78.7023125
MNAT1	0.191427889	0.731027928	1.696103486	0.307725316	1.79337135	0.002406826	116.2340892	5.41489558	7.584387945
MPG	0.070925227	0.630741254	0.886555283	0.842382995	0.235547071	0.030793696	0.078683597	0.252162294	4.428675777
MRE11A	0.438874717	1.132719384	0.499173727	0.612018815	0.268080563	0.54801961	0.553083727	428.636914	5800.734536
MSH2	0.003637951	1.32791123	0.627730213	1.235668004	0.657257794	0.003072144	154.1311775	2.852886916	4.355018226
MSH3	0.116480931	0.776396117	0.422346864	0.853874342	7.188808716	0.178550291	40.47167025	5.832209675	2940.210478
MUTYH	1.01779088	0.61392486	1.600205277	0.46453122	1.323412254	1.530369639	0.284168257	168.8072275	2009.079098
N4BP2	2.128013205	0.630921399	0.85099547	1.410220869	0.450563991	1.360997108	0.146806812	645.5900635	11974.05837
NBN	3.868631287	1.096725557	0.917098611	1.016692796	4.7357447	5.071950765	0.058487034	1088.479504	6911.895289
NTHL1	0.005551607	0.930241731	0.633518772	0.806766308	0.568687143	0.007271617	76.42465273	0.460010839	7.782911662
OGG1	0.507078104	1.227122693	0.749270749	0.574149432	0.983964962	1.095320729	17.66374407	11.05964872	44.8114646
PCBP4	0.113317553	1.027954101	1.202225075	0.901634452	1.764850216	0.283427422	0.238822789	5.572684874	17.05315332
PCNA	6.308071033	0.529144168	0.28971678	1.170312958	4.256006715	0.365923011	36.88483955	4.925232669	11360.08028
AIFM1	0.456524415	1.08086221	1.263848791	0.750133059	0.686153852	0.26569429	3.651063221	137.7034664	235.2473387
PMS1	17.06963077	0.413849357	2.16083292	0.550157487	0.528891335	4.132066739	0.122909224	848.5619119	4659.54127
PMS2	0.556536298	0.729721459	1.525949141	0.461850568	1.026533537	0.221174866	29.9443716	12.62417579	983.9635164
PMS2P3	0.090141698	0.593016559	0.176235315	0.91883773	1.175914953	0.082966685	38.82377974	286.1718573	10898.02741
PNKP	0.084310223	1.124730618	0.728071683	0.909544069	0.995299214	0.107978392	58.06474351	3.621397149	12876.25797
PPP1R15A	47.92116435	0.697061897	0.663491422	1.336016877	12.07350696	0.988582155	0.608377664	136.6631537	81.52791322
PRKDC	0.017404824	1.818927013	1.907221994	0.42647035	0.21938645	0.00715759	106.4413111	2041.827854	275452.40696
RAD1	12.54399364	0.481129481	0.935882861	1.911064825	1.857993458	16.90188271	0.023814335	3162.94402	25857.28595
RAD17	2.976964564	0.913679767	1.022983949	0.954388562	0.258552071	0.126775644	194.2322286	0.385380456	22.73431607
RAD18	0.112353578	1.339375318	1.578399632	1.372754092	1.481919146	0.079854712	15.41008259	0.65769154	2077.196496
RAD21	6.308071033	0.014957023	410.5417233	0.113175992	1.108693766	0.141689357	10.32163409	900.4704613	11360.08028
RAD50	1.223240084	25.94610132	0.926416183	2.8718232	1.696500433	0.00929927	42.63034491	1.719162426	11360.08028
RAD51	6.308071033	8.885729427	1.490698783	0.608444427	0.220702545	0.010294734	18.30427799	256.5695684	468.8752206
RAD51B	1.55385703	2.402230742	45.75682097	1.131399325	22.74264322	1.15500347	0.046069495	1716.647959	5854.775049
RAD9A	0.009582765	16.03098764	0.802980772	0.800818027	0.000697094	0.09685955	43.286933	3.823446218	71276.6264
RBBP8	0.285021604	0.863807152	1.144512061	1.850412538	0.834861488	0.078340429	0.197778009	0.265270297	11360.08028
REV1	0.118231496	0.623464535	0.495047088	2.637407198	0.002307947	0.262534957	77.01303331	0.902190108	5.478493467
RPA1	1.647663681	0.783428696	1.42859874	1.183641944	0.891835981	0.174400075	35.05357673	2.204138561	22.3395362
SEMA4A	0.004513006	0.952194974	2.807311487	1.266753644	1.704508476	0.00701405	278.554843	0.25766383	11360.08028
SESN1	0.657191323	0.777700806	1.074092987	0.555501649	0.593111824	0.140857096	20.16246389	7.910508139	2341.461232
SMC1A	0.984618868	0.928002418	1.317769455	1.061300755	0.859823306	0.936011549	0.548967016	11.92598443	194.9935562
SUMO1	0.141668097	0.953967854	1.190358536	0.673675711	0.726504393	0.207435104	31.10963473	0.508687252	4167.959384
TP53	1.003559392	0.741687776	1.860308832	0.720797113	1.789525028	0.445477235	517.9148249	0.2149689	174.9603093
TP73	0.007638542	0.805194599	0.439819467	0.755009812	0.482133958	0.002737386	1.700585174	1.067322414	63833.01415
TREX1	57.08463426	0.231059197	0.012661552	2.430880346	16.26476222	47.45509162	0.014362725	3252.853212	9567.843276
UNG	2.42614621	1.109785572	0.473848178	2.505510725	3.526761346	0.149852176	0.046617113	3.964541443	8.3179646
XPA	0.387858708	1.266954629	1.472618715	2.694663656	0.111503376	0.235635839	0.366906397	315.139887	247.2513904
XPC	18.38434758	1.082881097	1.410658142	0.504132599	1.608222218	3.910501998	0.041694374	816.686912	996.8292705
XRCC1	0.5460788	1.319962951	0.758654445	0.367624285	0.785485803	0.433250682	0.833787125	154.2853067	19792.90212
XRCC2	27.22614926	0.244680375	0.652659865	0.988468455	1.108693766	67.55450336	0.025381961	570.2500354	4082.565278
XRCC3	15.22637042	0.267308151	0.474280634	2.250271784	4.183251645	85.55845353	0.004746414	9497.418941	20654.02097
ZAK	4.064392746	0.881128185	1.020735929	0.566163174	1.540717024	0.614912218	0.293620999	266.5157271	4116.101696