

<MASLD>

전북대_김인희

기전	바이오마커		측정 가능한 연구 유형		
			in vitro	in vivo	human
대사 이상 관련 간의 지방 축적 지표	간 기능 관련	아미노전이효소:	○	○	○
	효소	ALT(Alanine aminotransferase),			
		AST(Aspartate aminotransferase)			
		GGT(gamma glutamyltransferase)	○	○	○
		ALP(alkialine phosphatase)		○	○
	간 기능 지표	총담즙산		○	○
		혈청 miR-122, miR-34a, miR-16, miR-192, miR-21		○	○
		MT-ND6 DNA methylation		○	○
		PPAR γ DNA methylation		○	○
	간 지방	영상진단			○
	수준	실험적 진단			
	지방대사	간초음파, CT, MRI, MRS, 간섬유화 검사(순간탄성측정법)			
		지방구 염색법, 중성지방정량, H&E 염색법	○	○	
		혈중지질수준(중성지방, 총콜레스테롤, HDL, LDL 등)	○	○	○
		지방합성 또는 분해 관련 효소 (FAS, FASN, ACC, AMPK)	○	○	
	염증반응	지방합성 또는 분해 관련 전사인자 (SREBP1c)	○	○	
		아디포넥틴	○	○	○
		사이토카인(Interleukine, chemokine 등), fragmented CK-18	○	○	○
		혈당, 인슐린, 당화혈색소(HbA1c), uric acid, homocysteine		○	○
	인슐린저항성	HOMA-IR		○	○
	인슐린신호전달	인슐린신호전달 (pAkt, pGSK, pFoxo)	○	○	
	항산화작용	지질과산화물(MDA), 항산화효소활성(SOD, catalase, GSH 등)	○	○	○
	간세포 사멸	Apoptosis pathway	○	○	
	임상증상개선	다차원피로척도, FSS(Fatigue severity scale), CIS(Checklist individual strength), 만성피로증후군 설문			○
		(Chalder fatigue scale)			
	비만도	신체계측			○
	혈압			○	○
	지방간 예측 점수				○
	장내미생물 관련 요인			○	○
	유전적 요인				○
생체이물 배설	배설능	빌리루빈		○	○
	Detoxification 관련 간내 효소	Phase I 반응효소(CYP1A1, 2 등) Phase II 반응효소(GST)		○	○

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기전	바이오마커		측정 가능한 연구 유형				
			in vitro	in vivo	human		
알코올 관련 간 지표	간 기능 관련		아미노전이효소:				
	효소		○	○	○		
						ALT(Alanine aminotransferase),	
						AST(Aspartate aminotransferase)	
			GGT(gamma glutamyltransferase)		○	○	○
			ALP(alkaline phosphatase)			○	○
	간 지방	영상진단	간초음파, CT, MRI, MRS, 간섬유화 검사(순간탄성측정법)				○
	수준	실험적 진단	지방구 염색법, 중성지방정량, H&E 염색법		○	○	
	지방대사	지방산산화	PPAR-a, AMPK, CD36, NAD+/NADH		○	○	
		지방산합성	SREBP1c, FAS, FASN, ACC		○	○	
		지단백분비	VLDL (중성지방)		○	○	○
		에너지상태	NAD+/NADH ratio		○	○	
			사이토카인(IL-1α, IL-1β, IL-6, IL-37, TNF-α 등), NK-kB, TGF-β1, CD14, CD571				
	항산화작용		지질과산화물(MDA), 항산화효소 활성(SOD, catalase, GSH 등)		○	○	○
	간세포 사멸		Apoptosis pathway		○	○	
	임상증상개선		다차원피로척도, FSS(Fatigue severity scale), CIS(Checklist individual strength), 만성피로 증후군 설문(Chalder fatigue scale), 알코올 식별 장애 테스트				○
비만도	신체계측	체중, BMI, 허리둘레, 체지방량, 복부지방량, 복부내장지방량, 사지근육량				○	
유전적 요인		GGT1 rs2006227, HNF1A rs1183910				○	
알코올 대사	알코올 대사		혈중 알코올농도, 제거속도, 혈중 알데히드 수준 변화, 제거속도			○	○
	알코올 대사 관련 효소		CYP2E1, ADH, ALDH			○	
생체이물 배설	배설능		빌리루빈			○	○
	Detoxification 관련 간내 효소		Phase I 반응효소(CYP1A1, 2 등) Phase II 반응효소(GST)			○	○

번호	참고 논문	핵심 키워드	시험 대상	실험 모델	주요 바이오마커
20	Idilman et al, 2020	genome-wide association studies (GWAS), nonalcoholic fatty liver disease, PNPLA3, steatohepatitis	European (Turkish)	NAFLD, Health	- Baseline characteristics (ALT, AST, GGT etc) - Histological Assessments-Liver biopsy - PCR-DNA sequencing - Statistical analysis
26	Pirola et al, 2015 [26]	Liver, Nonalcoholic Steatohepatitis	American	NAFLD, Health	- serum miRNA profiling - Independent validation of selected miRNA - Evaluation of liver expression of candidate miRNAs - Inflammation marker leucocyte count and C reactive protein, sICAM-1, PAI-1, soluble CD40 ligand, CK-18
27	Yamada et al, 2013 [27]	Circulating microRNA, Cross-sectional study, Epidemiology, General people, Liver steatosis, NAFLD	Japanese	NAFLD, Health	- Blood biochemistry - miRNA (miR-21, miR-34a, miR-122, miR-145 and miR-451)
28	Yip et al, 2017 [28]	NAFLD, Epidemiological study, AUROC, machine learning	Chinese	NAFLD, Health	- Baseline characteristics (ALT, AST, NA, K, creatinine, uric acid etc) - Statistical analysis
29	Drescher et al, 2019 [29]	algorithms; biomarkers; fibrosis; grading; imaging; nonalcoholic steatohepatitis; scores	-	NAFLD, NASH, fibrosis	- Blood biomarker panels to identify inflammatory liver disease.
30	Kottronen et al, 2009 [30]	1H-MRS, AROC, BP, BMI, fasting plasma, fasting serum, hepatitis B virus, hepatitis C virus, NAFLD, PNPLA3, ROC, SNP	European	NAFLD, Health	- Baseline characteristics (ALT, AST, blood counts, creatinine, Hepatitis B virus, hepatitis C virus serology, transferrin saturation etc) - Genotyping - Diagnosis of the Metabolic Syndrome - Statistical analysis
31	Lee et al, 2010 [31]	Body mass index, Fatty liver, Hepatic steatosis index, Screening	Korean	NAFLD, Health	- Baseline characteristics (ALT, AST, BMI, SBP, DBP, TG, GGT etc) - Statistical analysis
32	Jeong et al, 2020 [32]	NAFLD; insulin resistance; metabolic risk factors; non-invasive diagnosis	Korean	NAFLD, Health	- Baseline characteristics (BMI, SBP, DBP, TG, HDL, WC, AST, ALT etc) - Statistical analysis
33	Bedogni et al, 2006 [33]	FL, NAFLD, obesity, GGT, BMI	European	FL, Health	- Baseline characteristics (ALT, AST, BMI, GGT etc) - Statistical analysis
34	Calori et al, 2011 [34]	Insulin resistance, FL, BMI, CVD	European	FL, Health	- Baseline characteristics (TG, BMI, WC, GGT, HDL, insulin etc) - Statistical analysis
50	Kim et al, 2022	ALD, AST, ALT, GGT1, HNF1A, alcohol, PNPLA3, SNP	Korean	alcohol intake (non, light, high)	- Baseline characteristics (ALT, AST, total bilirubin, blood urea nitrogen, serum creatinine, white blood cell counts etc) - PCR-DNA sequencing - Statistical analysis

번호	참고 논문	핵심 키워드	시험 대상	실험 모델	주요 바이오마커
69	Cermelli et al, 2011 [69]	blood, Case-Control Studies, Fatty Liver, Hepatitis C, MicroRNAs, Non-alcoholic Fatty Liver Disease	micro RNA miR-122, miR-34a, miR-16 and miR-21	cell : Huh7.5 cell / HCV virus human : chronic hepatitis C, NAFLD, Health	- cell miR-122, miR-34a, miR-16 level - serum miR-122, miR-34a, miR-16 level
71	Pirola et al, 2013 [71]	DNA methylation, MT-ND6, NAFLD, epigenetics, mitochondria	MT-ND6 methylation	NAFLD, Health	- MT-ND6 methylation - Liver MT-ND6 mRNA expression - DNA (cytosine-5) methyltransferase 1
72	Hajri et al, 2021 [72]	DNA methylation, epigenetic, high-fat diet, non-alcoholic fatty liver disease (NAFLD)	C57BL6 mouse	C57BL6 mouse / with HFD, fat provided 60% energy, mainly as saturated fat (palm oil) or LFD diet provided 10% calories from fat	- Triglycerides, cholesterol, free fatty acids - TNF- α and interleukin-6 (IL-6) - expression of ppary, cd36, and 피익 - Hepatocyte fatty acid uptake - Cell Viability - DNA Methyltransferase Activity
73	Soto et al, 2024 [73]	MASLD; NAFLD; organoids; pathophysiology	-	MASLD	- Risk Factors for MASLD - Genetic Pathways Related to MASLD - The Future with Organoids - Therapy
74	Thing et al, 2024 [74]	Acetate; Butyrate; Circulating SCFA; Cirrhosis; Metabolome; Microbiome; Non-alcoholic fatty liver disease; Non-alcoholic steatohepatitis; Propionate; Targeted metabolomics	European	MASLD, Health	- gas chromatography-tandem mass spectrometry(GS-MS/MS) - linear regression
76	Yu et al, 2019 [76]	Advanced fibrosis, Glycated hemoglobin A1c, Non-alcoholic fatty liver disease, Obesity	Chinese	NAFLD, Health	- HbA1c
77	Xie et al, 2022 [77]	HbA1c, NAFLD, NHANES, Steatosis, Transient elastography	American	non-diabetic NAFLD, Health	- Baseline characteristics (HbA1c, ALT, AST, GGT, TG etc) - Multivariate regression analysis between HbA1c and the prevalence of NAFLD
78	Wei et al, 2020 [78]	cohort study, hyperuricemia, non-alcoholic fatty liver disease, risk factor, serum uric acid	Chinese	non history of chronic liver disease NAFLD, Health	- Ultrasonography - Baseline characteristics (ALT, AST, TG, HbA1c, uric acid etc) - Cox Regression Analysis of serum uric acid Levels for Incidence NAFLD
79	Dai et al, 2016 [79]	Body mass index, Gender, Homocysteine, Interaction, Non-alcoholic fatty liver disease	Chinese	NAFLD, Health	- Baseline characteristics (ALT, TBIL, PLT, TG, creatinine, homocysteine etc) - Statistical analysis

주요 기전	Ref 번호	실험 모델	측정 바이오마커	바이오마커 측정 방법	실험설계 시 고려사항
간 기능 지표	26	human serum and plasma	micro RNA : miR-122, miR-192, miR-19a 및 miR-19b, miR-125b 및 miR-375	RT-PCR	
	27	human serum and plasma	micro RNA : miR-21, miR-34a, miR-122, miR-451	RT-PCR	
	69	Huh7.5 cell, human serum and plasma	micro RNA : miR-122, miR-34a, miR-16 및 miR-21	RT-PCR	
	71	human liver tissue	DNA methylation MT-ND6	amplicon PCR	
	72	C57BL6 mouse liver tissue	DNA methylation PPAR-γ	amplicon PCR	fat provided 60% energy, mainly as saturated fat
인슐린 저항성	76	Asian(Chinese)	HbA1c	Cohort study	non-diabetic, restriction of alcohol intake
	77	American	HbA1c	Cohort study	non-diabetic
	78	Asian(Chinese)	Uric acid	Cohort study	
	79	Asian(Chinese)	Homocysteine	Cohort study	
지방간 예측 점수	28	Asian(Chinese)	NAFLD ridge score NRS	Cohort study, Machine learning	
	29	-	NAFLD ridge score NRSNAFLD liver fat score NLFS	review	
	30	European	NAFLD liver fat score NLFS	amplicon PCR, machine learning	
	31	Asian(Korean)	Hepatic steatosis index HSI	Multivariate analysis	
	32	Asian(Korean)	Hepatic steatosis index HSI	Multivariable-adjusted logistic regression	without history of liver disease and alcohol consumption
	33	European(Italian)	Fatty liver index FLI	stepwise logistic regression analysis	
	34	European(Italian)	Fatty liver index FLI	Statistical analysis	
장내미생물 관련 요인	73	-	serum TMA, TMAO, SCFA	review	
	74	European	serum SCFA	gas chromatography-tandem mass spectrometry (GC-MS/MS)	
유전적 요인	20	European(Turkish)	PNPLA3(rs738409) genetic variant	PCR-DNA sequencing	
	50	Asian(Korean)	GGT1(rs2006227) and HNF1A(rs1183910) genetic variant	PCR-DNA sequencing	