

Liver Hepatocellular Carcinoma (LIHC)

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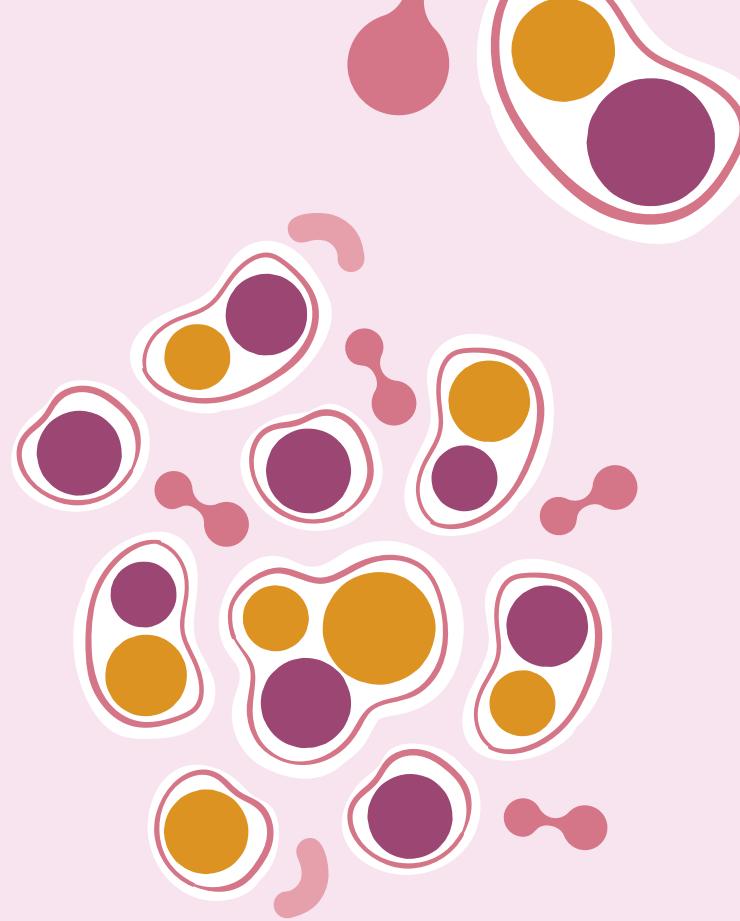


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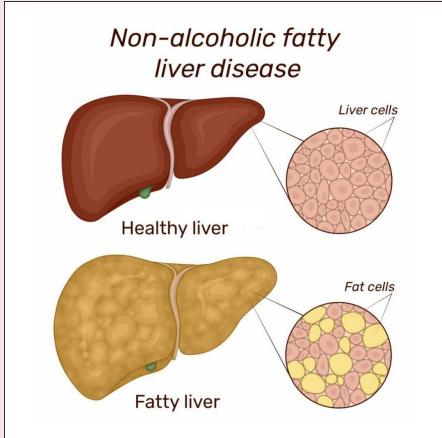
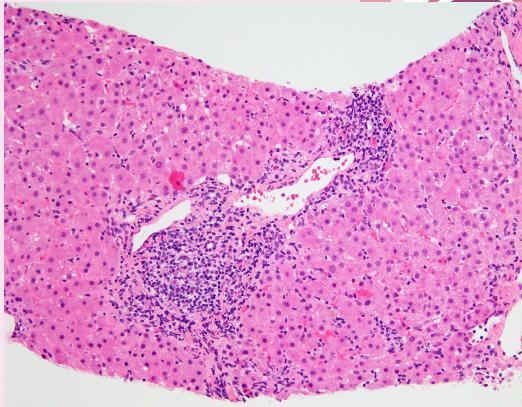


01

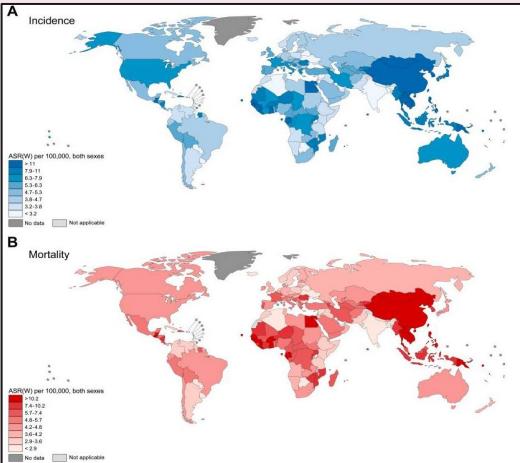
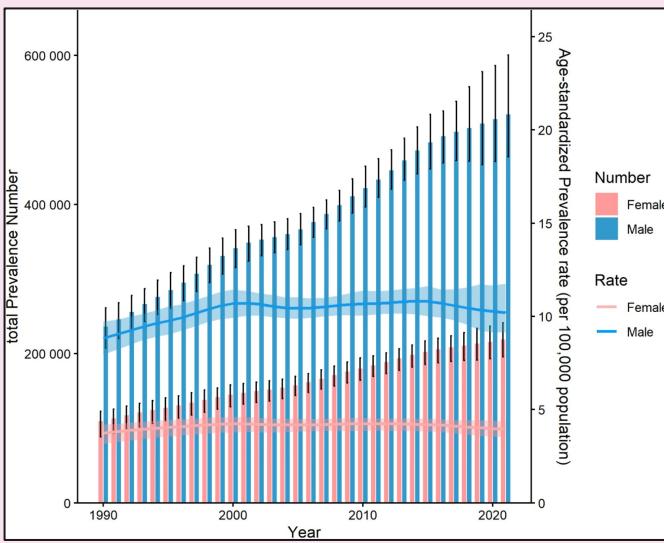
Statistics

Global Ranking & Historical Trends

- **Fourth** most common cause of death globally (avg: 800,000 annual deaths)
 - In 2022, ~866,000 new cases,
~758,000 deaths <- **3rd** leading cause of cancer death
- Hepatocellular carcinomas represent approximately 90% of primary liver cancers (90% of these carcinomas are associated with a known underlying cause, i.e. chronic viral hepatitis, heavy alcohol consumption)



- Number of prevalent cases and the age-standardized prevalence rate of liver cancer were significantly higher in **males** than in females (70.41%)
- Regional hotspots:
(Incidence rates):
Eastern Asia (>50% of cases), Northern Africa, Micronesia
(Mortality rates):
Eastern/Southeastern Asia, Northern Africa, Micronesia
- China alone accounts for 45.3% of the world's liver cancer cases, 47.1% of liver cancer deaths**





02

Symptoms

Symptoms

- Weight loss
- Loss of appetite
- Nausea
- Vomiting
- Abdominal pain or swelling
- Jaundice
- Itching
- Easy bruising or bleeding
- Some liver tumors may produce hormones that can lead to symptoms affecting other organs
 - High or low blood calcium levels
 - Low blood sugar
 - Increased red blood cell counts



03

Diagnostics

Diagnostics

Imaging

CT scans, MRI's, and ultrasounds help visualize the tumor and its characteristics.

Blood Tests

Used to indicate the presence of cancer.

Liver Biopsy

Often required for definitive diagnosis and to determine the specific type and grade of a cancer.



04

Treatment

Treatment

Surgery

If the cancer is localized (in early stages), doctors may advise removal via surgery.

Arterial Embolization

Embolizing specific arteries blocks blood flow to the tumor, limiting its ability to gain necessary nutrients and spread further.

Targeted Therapy

Certain drugs, immunotherapies, and radiation therapies are all treatments advised by doctors.

Liver Tumor Ablation

A minimally invasive treatment that destroys liver tumors using focused energy or extreme heat. It's an option for patients who are not candidates for surgery or have tumors that are not surgically removable.

Treatment options

Treatment option	Efficacy rate	Side effects	Cost	Availability
Surgical Resection	75%	Mild	\$\$\$	Widely available
Liver Transplant	70%	Moderate	\$\$\$\$	Available only with prescription
Radiofrequency Ablation	90%	High	\$\$\$\$	Requires specialized facilities
Immunotherapy	15-20%	Moderate	\$\$\$\$	Available only in select medical centers
TransArterial ChemoEmbolization (TACE)	60%	Mild	\$\$\$	Widely available



05 Associated miRNA

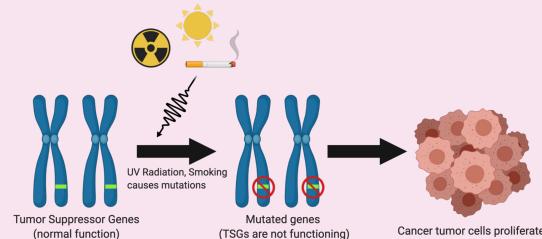
Associated miRNA - Tumor Suppressors

LIHC Prominent

miR-199a

Let-7c-5p

miR-490



Multi-Carcinoma Prominency

miR-9-3

miR-551A

miR-100

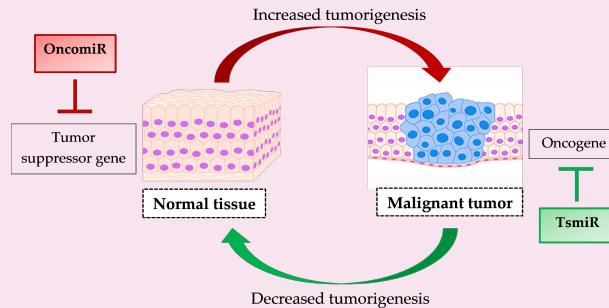
Associated miRNA - Oncogenes

LIHC Prominent

miR-21

miR-155

miR-93



Multi-Carcinoma Prominency

miR-9-5p

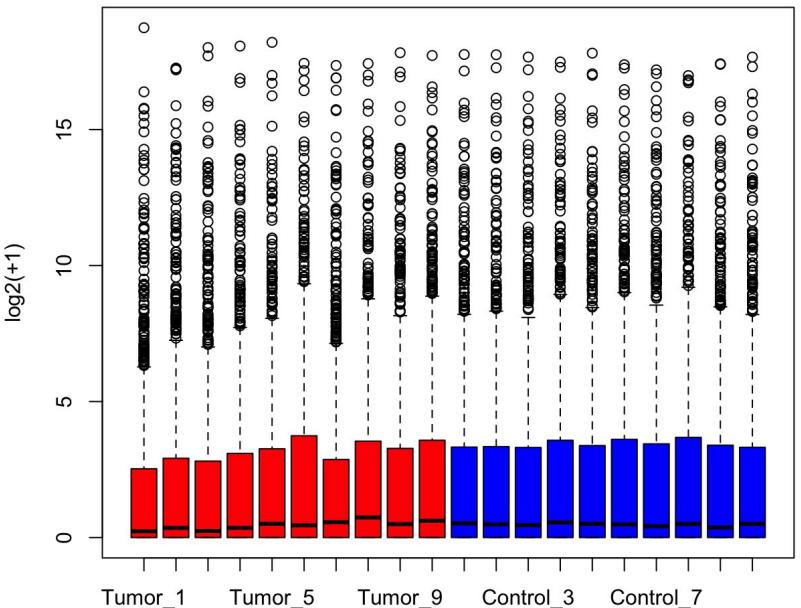
miR-425-5p

miR-187

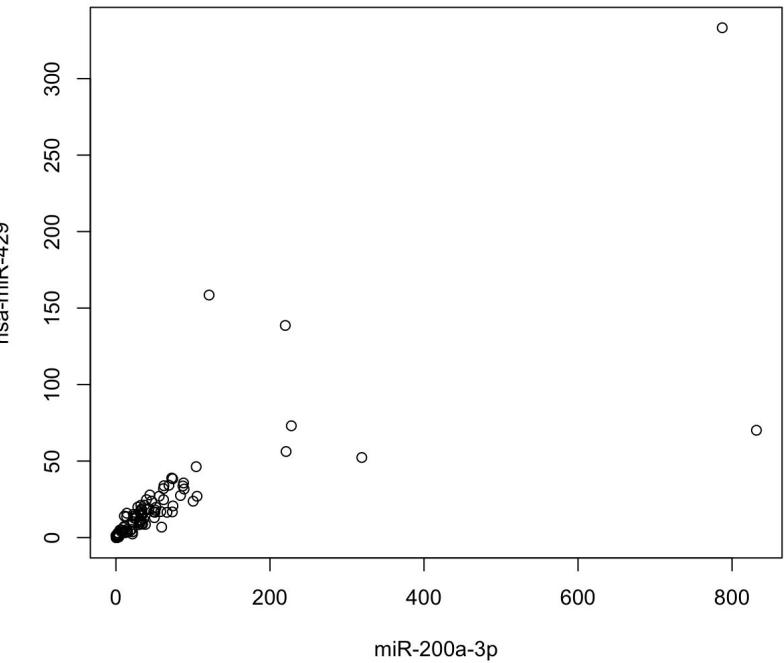
Our Results

Scatter and Box Plots

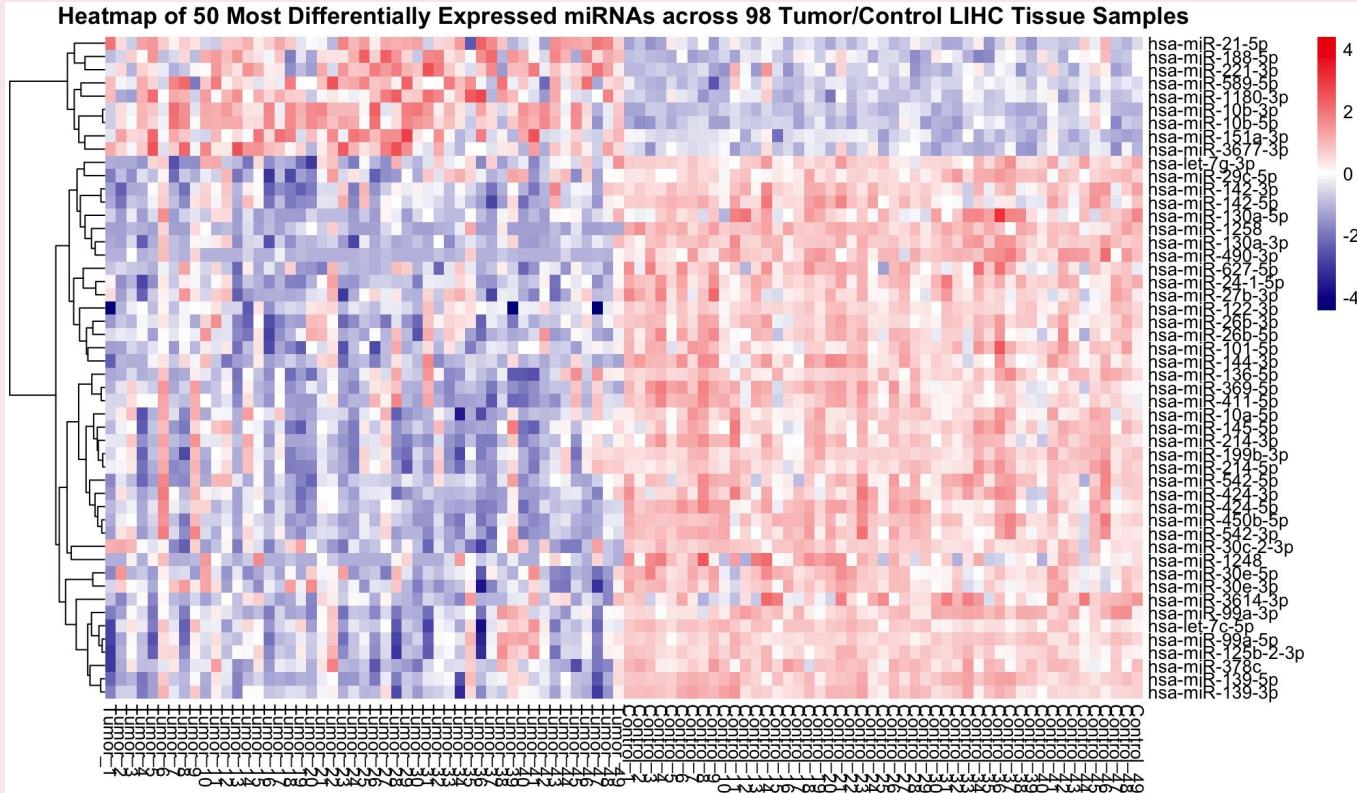
Expression of miRNAs across Tumor and Control Samples



Expression of miR-200a-3p vs hsa-miR-429



Heatmap

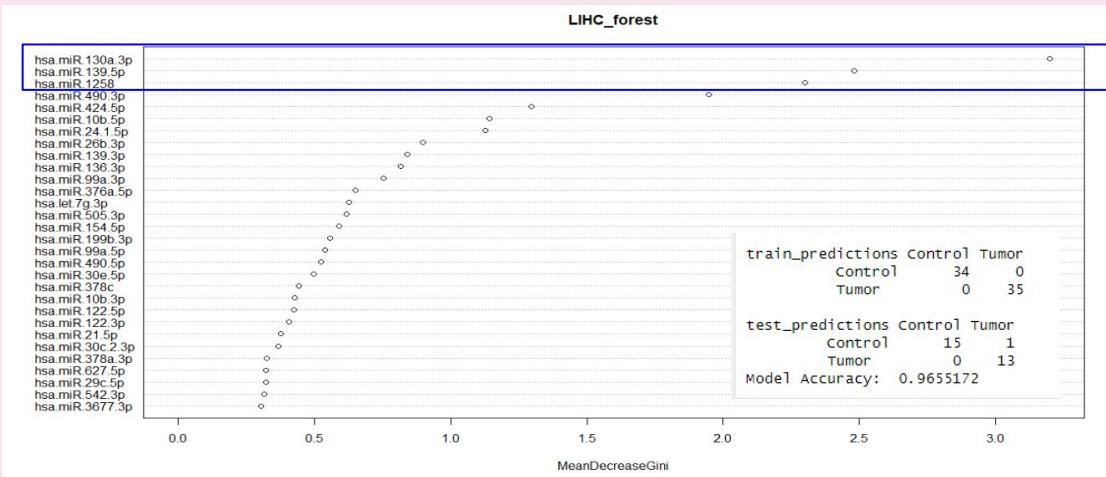


Correlation Analysis

##	hsa-miR-139-5p	
##	hsa-miR-139-5p	1.0000000
##	hsa-miR-1258	0.8903033
##	hsa-miR-130a-3p	0.8373136
##	hsa-miR-139-3p	0.7614496
##	hsa-miR-24-1-5p	0.7306879
##	hsa-miR-450b-5p	0.7161877
##	hsa-miR-122-3p	0.7120360
##	hsa-miR-99a-3p	0.7080824
##	hsa-miR-424-5p	0.7034904
##	hsa-miR-199b-3p	0.6886344
##	hsa-miR-490-3p	0.6586408
##	hsa-miR-101-5p	0.6569358
##	hsa-miR-26b-3p	0.6277115
##	hsa-miR-424-3p	0.6248258
##	hsa-miR-542-5p	0.6208287
##	hsa-miR-378c	0.5974471
##	hsa-let-7c-5p	0.5917185
##	hsa-miR-214-3p	0.5878826
##	hsa-miR-627-5p	0.5787771
##	hsa-miR-542-3p	0.5780950
##	hsa-miR-30e-5p	0.5765826
##	hsa-miR-130a-5p	0.5593810
##	hsa-miR-10a-5p	0.5355133
##	hsa-miR-21-5p	0.5239903
##	hsa-miR-142-3p	0.4449979
##	hsa-miR-10b-3p	0.4203202
##	hsa-miR-144-3p	0.3706020
##	hsa-miR-214-5p	-0.5390903
##	hsa-let-7g-3p	-0.5980656

The most correlated miRNAs were our most significant (miR-139-5p) and miR-1258, with a correlation of 0.89. Following, miR-130a-3p had a large correlation of 0.83, with miR-139-3p and miR-24-1-50 following with .76 and .73 correlation values, respectively. Correlation values ranged gradually between 0.83 and 0.37 for the first 27 correlations. However, miR-214-5p and miR-let-7g-3p displayed negative yet significant correlations of -0.53 and -0.59, respectively. Overall, the first 29 most significant miRNAs showed relatively significant correlations with miR-139-5p, supporting the evidence of statistical significance that their respective p-values demonstrated.

Random Forest



Explanation

Random Forest is an ensemble machine learning algorithm that combines multiple decision trees to improve predictive accuracy and reduce overfitting.

Graph

The graph shows the importance of each miRNA in classifying whether the sample was Tumor or Control.

	Control Mean	Tumor Mean	Control SD	Tumor SD	P-val
hsa-miR-139-5p	379.4097855	96.5564126	116.5352512	91.9993305	1.291949e-21
hsa-miR-1258	15.0685431	1.8081190	6.4910703	3.9295721	6.435790e-20
hsa-miR-130a-3p	119.8130850	33.3920733	42.4617922	28.2763565	1.349537e-19
hsa-miR-139-3p	103.1032523	32.9355147	34.2465273	26.2784095	4.128606e-19
hsa-miR-24-1-5p	41.7828642	17.7790975	12.1621064	9.8254802	6.282353e-18
hsa-miR-450b-5p	27.9909052	9.2771934	9.7535837	7.4951324	1.285701e-17
hsa-miR-122-3p	417.4979216	167.4460462	125.7190403	119.0744799	8.968665e-17
hsa-miR-99a-5p	7.5682670	2.6388526	2.6227990	2.5318163	2.116474e-15
hsa-miR-424-5p	655.3268776	172.3000070	335.0446514	196.9018760	4.267693e-13
hsa-miR-199b-3p	2669.9509683	948.4512402	1047.0034145	1011.4026541	7.360737e-13
hsa-miR-490-3p	8.6569527	0.5889785	5.9247866	1.5925519	1.010751e-12

Conclusions

As you can see, the top three most important miRNAs in classifying whether a sample is a Tumor or Control are the miRNAs that are most statistically significant (or in other words, differentially expressed).

Statistically Significant miRNA in our Data

hsa-miR-139-5p

Research suggests that miR-139-5p can inhibit cancer cell invasion and proliferation, potentially by targeting genes like SLTRK4. In other words, when miR-139-5p is reduced, it may lead to increased cancer cell growth and spread. miR-139-5p is downregulated in our tumor data.

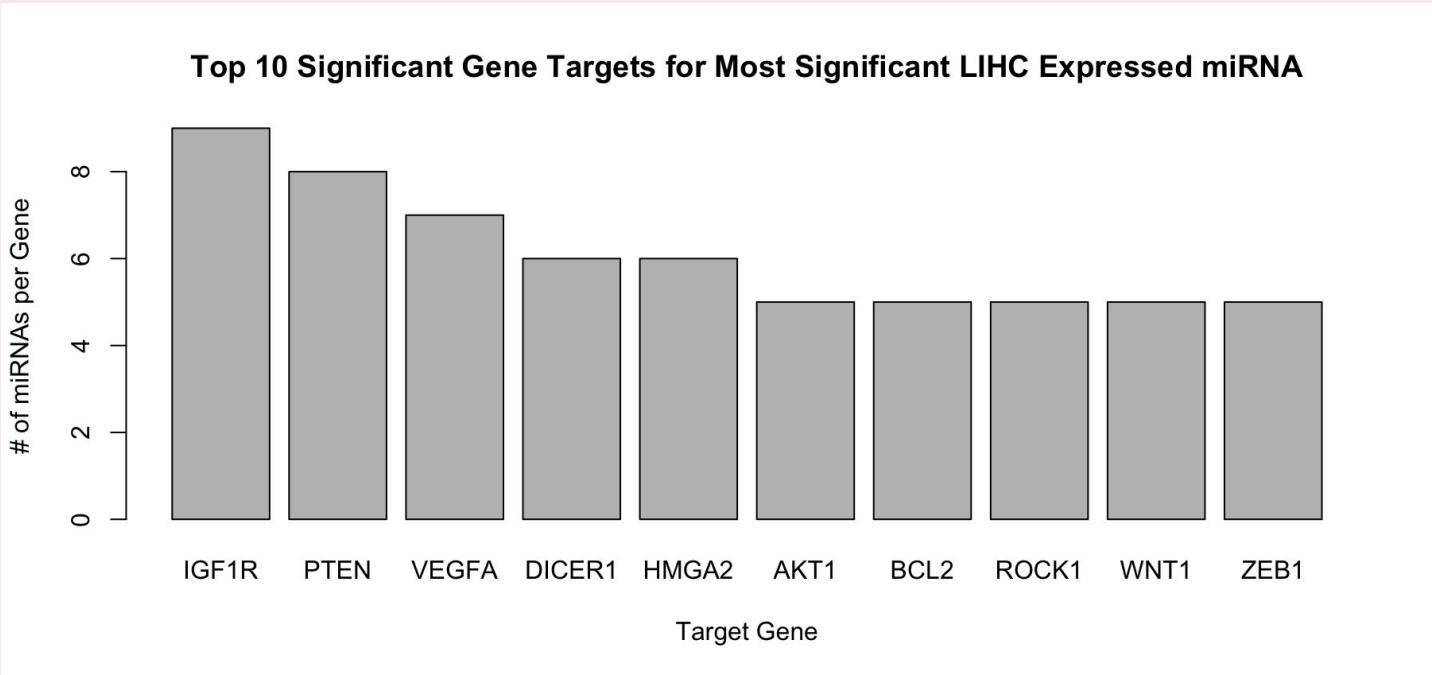
hsa-miR-1258

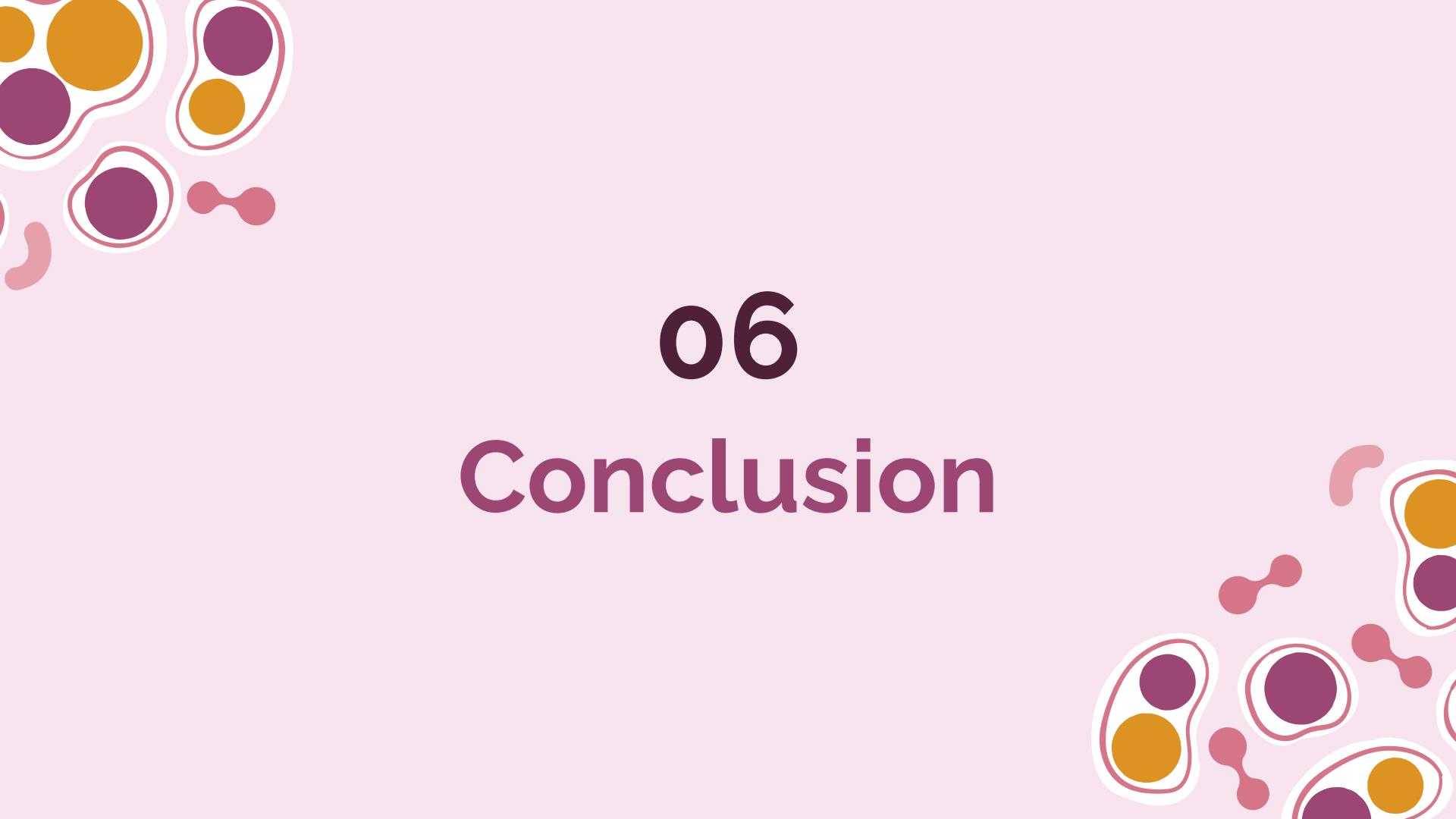
miR-1258 has been shown to target CKS1B, a protein that promotes cell cycle progression and cancer cell proliferation. By targeting CKS1B, miR-1258 may inhibit these processes. miR-1258 is also downregulated in our tumor data.

hsa-miR-130a-3p

plays a role in liver cancer by acting as a tumor suppressor. Some of the genes that miR-130a-3p targets in liver cancer include TGFBR1, TGFBR2, and Smad4. By targeting these genes, miR-130a-3p can influence cell proliferation, migration, and invasion in liver cancer. miR-130a-3p is downregulated in our data.

Key Gene Targets and Connections





06

Conclusion

Conclusion

miRNA Uses

We determined that miR-139-5p, miR-1258, and miR-130a-3p were the most differentially expressed miRNAs in our dataset. They were also the most important miRNAs for classifying samples with the random tree algorithm. As such, we have concluded that there is a high probability that their downregulation is a biomarker for LIHC.

Genes

IGF1R, targeted by nine of our significant miRNAs, encodes the insulin-like growth factor 1 receptor—a protein commonly overexpressed in cancer. Its upregulation promotes anti-apoptotic signaling, allowing unchecked cell growth and survival. This suggests that the miRNAs targeting IGF1R may be downregulated in LIHC, enabling its overexpression. Similarly, PTEN, targeted by eight miRNAs, is a tumor suppressor frequently inactivated in cancer. Its presence as a common miRNA target aligns with its critical role in controlling proliferation. Overall, our findings highlight key patterns in miRNA–gene interactions in LIHC and provide both statistical and biological insights that may inform future research.

Sources

[https://pmc.ncbi.nlm.nih.gov/articles/PMC10121295/](https://PMC10121295)

https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-025-22026-6?utm_source

[https://pmc.ncbi.nlm.nih.gov/articles/PMC9670241/](https://PMC9670241)

https://pubmed.ncbi.nlm.nih.gov/32285917/#:~:text=Abstract,cell%20invasion;%20microRNAs;%20proliferation.

[https://www.mayoclinic.org/diseases-conditions/liver-cancer/diagnosis-treatment/drc-20353664#:~:text=Alanine%20aminotransferase%20\(ALT\)%20blood%20test,Ultrasound%20Show%20more%20related%20information](https://www.mayoclinic.org/diseases-conditions/liver-cancer/diagnosis-treatment/drc-20353664#:~:text=Alanine%20aminotransferase%20(ALT)%20blood%20test,Ultrasound%20Show%20more%20related%20information)

https://www.ncbi.nlm.nih.gov/gene/100302172#:~:text=Loss%20of%20miR%2D1258%20contributes%20to%20carcinogenesis%20and%20progression%20of%20liver%20cancer%20through%20targeting%20CKS1B.

<https://www.ncbi.nlm.nih.gov/gene/3480>

<https://medlineplus.gov/genetics/gene/pten/>

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